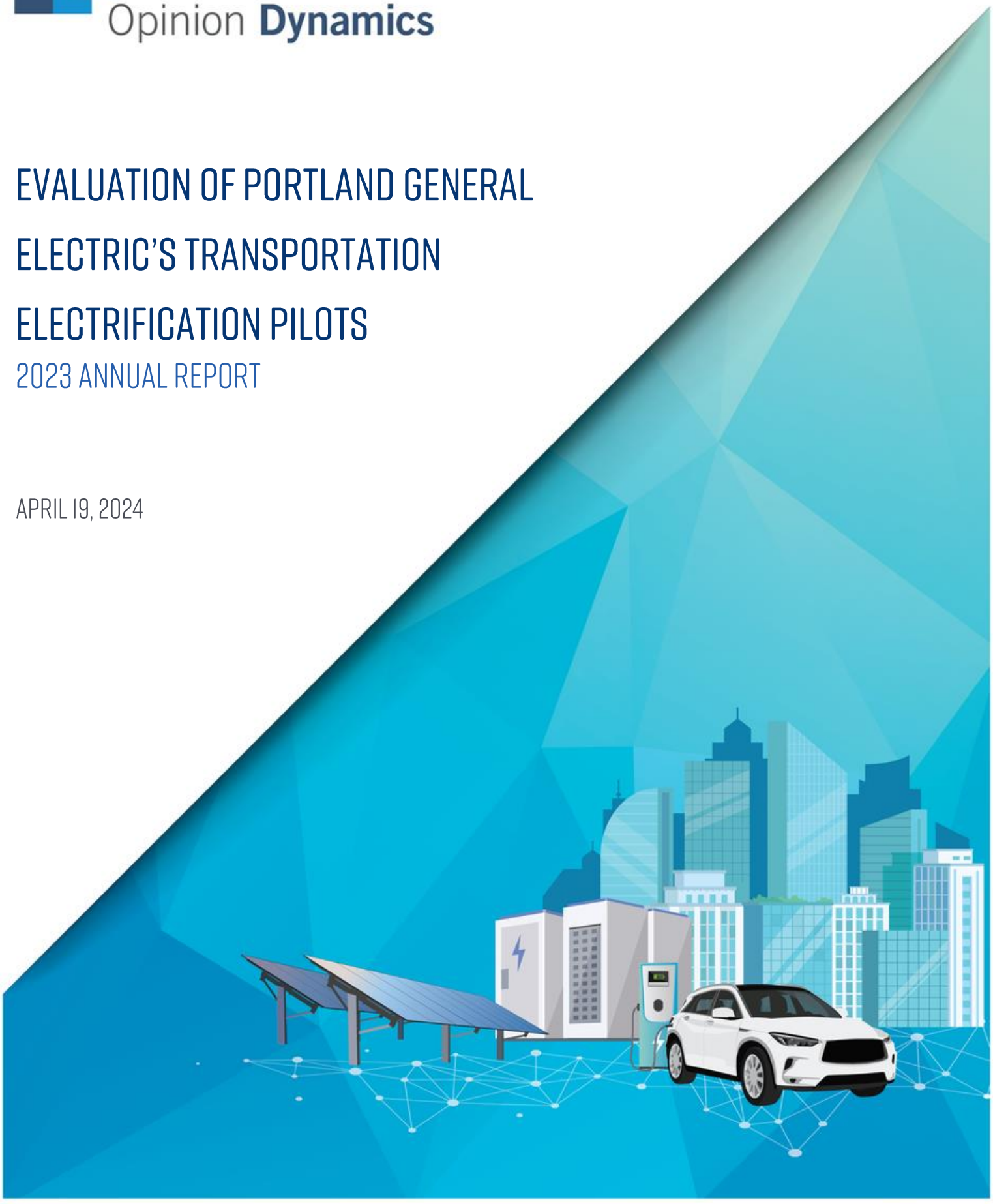
Opinion Dynamics

EVALUATION OF PORTLAND GENERAL ELECTRIC'S TRANSPORTATION ELECTRIFICATION PILOTS

2023 ANNUAL REPORT

APRIL 19, 2024



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I.I PILOT SUMMARY AND EVALUATION ACTIVITIES

PGE has been working towards promoting greater electrification of the transportation sector by developing and implementing a wide range of programs. These programs are designed to cater to the needs of residential customers (single and multifamily), private and public fleet operators, municipalities, and businesses. Building from learnings from previous transportation electrification (TE) pilot programs, PGE launched three new pilots starting in 2020: Residential Electric Vehicle (EV) Smart Charging (Residential Charging Pilot), Business EV Charging Rebates (Business Charging Rebates Pilot), and the Fleet Partner Pilot. The following table summarizes each pilot's primary objectives and evaluation activities conducted by Opinion Dynamics ("the team"). This evaluation report covers pilot activities running from each pilot's inception through the second quarter of 2023. Results are reported for evaluation activities conducted between April 2023 to October 2023.

In the 2024 Annual Report, the team will provide evaluation results of Residential Charging Pilot activities conducted during the Summer 2023 and the Winter 2023/2024 event seasons. For the Business Charging Rebates Pilot and Fleet Partner Pilot, the 2024 report will cover pilot activities conducted from the third quarter of 2023 through the second quarter of 2024.

Table 1. Overview of Transportation Electrification Pilots

Pilot	Pilot Objective	Pilot Launch	Evaluation Activities
Residential Charging Pilot	Shift EV charging away from times of high system energy demand or when energy prices are highest. In exchange for rebates for Level 2 electric vehicle supply equipment (EVSE/chargers) and/or a credit on their electric bill, pilot participants allow PGE to control their EV charging during defined event hours. The pilot stops charging during these event hours on every non-holiday, weekday of each season. The winter season runs from October to March and the summer season from April to September.	2020; first event season in October 2021	▪ Interviews with PGE staff and implementation partners. ▪ Post-event survey with Winter 2022/2023 Event Season participants. ▪ Winter 2021/2022, Summer 2022, and Winter 2022/2023 Event Season impact and charging pattern analysis.
Business Charging Rebates Pilot	Accelerate EV adoption by ensuring adequate charging infrastructure is available to meet commercial customers' charging needs, reduce the cost and complexity of installing EVSE, and create a network of demand response (DR) enabled EVSE that can support efficient grid operations and future integration of renewables. The pilot provides tiered rebates for Level 2 EVSE and, up until April 2023, rebates for make-ready installations and DC Fast Chargers (DCFC).	2020	▪ Interviews with PGE staff. ▪ Interviews with participants who received rebates through the pilot. ▪ Charging pattern analysis.
Fleet Partner Pilot	Reduce costs and complexities for managers of nonresidential fleets who are interested in transitioning to electric fuel and creating a network of DR-enabled EVSE that can support efficient grid operations and future renewables integration. The pilot includes a Plan phase, which includes a fleet assessment and electrification plan, and a Build phase, which includes designing and constructing PGE-owned make-ready infrastructure.	2021	▪ Interviews with PGE staff and implementation partners. ▪ Interviews with fleet managers who applied but withdrew their application from the pilot. ▪ Online surveys with fleet managers who completed the Plan phase of the pilot. ▪ Interviews with those who completed the Build phase of the pilot. ▪ Charging pattern analysis

1.2 KEY FINDINGS AND RECOMMENDATIONS

The following section provides key evaluation findings and recommendations by pilot. Evaluation activities will continue through 2024, which will allow the team to monitor and expand on these findings.

1.2.1 RESIDENTIAL CHARGING PILOT

Pilot Participation Trends: Residential Charging Pilot enrollment has been strong, and the pilot has the opportunity to meet enrollment targets. However, to do so, the pilot may need to expand efforts to attract more EVSE participants. During the Winter 2022/2023 Event Season, 2,717 participants were enrolled in the pilot across the EVSE and evPulse channels. This is nearly double the number of participants from the Summer 2022 season and a 150% increase from the pilot's first season (Winter 2021/2022). Annual cumulative enrollment fell short of the 2022 target for unique chargers/vehicles but exceeded the target for 2023. Enrollment in the evPulse channel has driven growth in the pilot between the Summer 2022 and Winter 2022/2023 Event Seasons, exhibiting a 179% increase compared to a 52% increase in the EVSE channel. Nearly all EVSE participants received a standard charger rebate, with few receiving a Bring Your Own Charger (BYOC) rebate.[1] Results from a 2023 survey with EV Owners in PGE's service area show that about two-thirds of EV owners are not aware of the Residential Charging Pilot.[2] Residential Charging Pilot enrollment levels by event season and year are detailed in Section 3.1.

- **Recommendation:** Continue to increase EVSE enrollment in the pilot using targeted marketing to existing EV owners who are not enrolled in the pilot and may be eligible because they have a charger on the qualified products list (QPL). As of September 2023, a majority of EV owners in PGE's service area were not aware of the Pilot and may be eligible to participate.

Pilot Awareness and Marketing: Residential Charging Pilot Participant feedback suggests that current marketing priorities are well-aligned with customer preferences. Nearly three-quarters of participants report learning about the pilot through the PGE website or emails from PGE, which is the primary way the pilot is marketed. Participants report their primary motivation to participate was the rebate they received for their charger, but also report being motivated by the environmental benefits of participation and the seasonal charging incentives.

- **Recommendation:** Continue to rely upon the PGE website and email outreach to drive Pilot participation, as this has been an effective approach. Future marketing should continue to highlight the various benefits of the pilot, emphasizing charger rebates. PGE should also consider additional ways to publicize available tax credits for purchasing and installing charging.

Pilot Satisfaction and Participation Requirements: Residential Charging Pilot participants in both the EVSE and evPulse channels had a generally positive experience and were satisfied with their participation. However, a small percentage of participants (5% or less) faced challenges during the enrollment process. Areas of dissatisfaction noted by participants included the lengthy application process, the complexity of installing charging, difficulty finding a contractor, and delayed or non-response from pilot staff when reaching out with questions. Additionally, approximately one-third of EVSE participants and one-half of evPulse participants were unable to accurately identify the seasonal incentive requirements as part of the post event survey. Among participants who did not qualify for a seasonal incentive, about one-quarter indicated that the email informing them they did not qualify for the incentive did not make it clear what they needed to do differently to qualify in future seasons. Section 3.3 provides further detail and discussion around Pilot satisfaction and participation processes.

[1] BYOC rebates of $50 are available upon enrollment in the Residential Charging Pilot if a customer purchased and installed an eligible charger before the charger was added to the QPL. As such, BYOC participation is expected to decline as more chargers are added to the QPL.
[2] Survey results will be included in the upcoming UM1811 2023 Annual Report.

- **Recommendation 1:** Look for ways to streamline the application process to limit customer burden,[3] and ensure customer questions are responded to in a timely manner.
- **Recommendation 2:** Ensure customers have access to a list of qualified contractors they can reference when installing chargers,[4] and that contractors on the list receive details about the Residential Charging Pilot so they can ensure charger installations meet program requirements (i.e., the charger is on the Qualified Product List, the charger is hardwired, etc.).
- **Recommendation 3:** Consider additional targeted outreach to Pilot participants who continually do not receive seasonal incentives to inform them about the requirements and encourage participation.

Load Management Impacts: For the EVSE channel, the pilot achieved an average per charger demand impact of 0.37 kW during the Winter 2021/2022 Event Season, 0.40 kW during the Summer 2022 Event Season, and 0.49 kW during the Winter 2022/2023 Event Season, exceeding the 0.45 kW planning assumption for the third season.

The absolute level of charging load reduction is driven by the amount of baseline load available to shift and not customer behavior. Treatment Group C had consistently higher per charger load reduction than Group B. Across the three seasons, the average per charger load reduction was 0.54 kW for Group C and 0.29 kW for Group B. The difference is mainly due to the larger amount of baseline load available to shift during the Group C event window. The baseline charging load during the Group C window of 10 p.m. – 11:59 p.m. was 0.71 kW compared to 0.38 kW during the Group B window of 5 p.m. – 8 p.m. The amount of load reduction relative to the baseline was similar for the two treatment groups (an average of 76% for Group C and 78% for Group B across the three event seasons) suggesting that charging interventions are equally successful throughout the evening.

Group C's higher absolute load reduction is also due to Time of Day (TOD) enrollees being assigned to Group C. The baseline charging load of TOD enrollees was nearly double that of non-TOD pilot participants during the Group C window (1.06 kW compared to 0.58 kW during the Winter 2022/2023 Event Season). TOD enrollees in the control group, which provided the estimates of baseline load, shifted their charging to late-night hours, overlapping the Group C event window, whereas non-TOD control group members conducted more of their charging during early to mid-evening hours.

- **Recommendation:** For the EVSE channel, consider using the unmanaged charging patterns of Group A, the control group, to set planning assumptions for achievable load shifting for different event windows and for customers who are on the TOD rate. Based on the evaluation team's analysis of the first three event seasons, we make the following recommendations for the per charger planning assumption of each treatment group.

Table 2. Recommended Load Reduction Planning Assumptions for the Residential Charging Pilot EVSE Channel

Treatment Group	kW Load Reduction Per Charger Planning Assumption
B (5:00 p.m. – 8:00 p.m.)	0.30
C TOD (10:00 p.m. – 11:59 p.m.)	0.75
C Non-TOD (10:00 p.m. – 11:59 p.m.)	0.40

- The per charger planning assumption for the overall pilot should be a weighted average based on the number of enrollees per treatment group.

Load Impact Variability: Across the three event seasons, we observed growth in the amount of curtailable charging load and seasonal variation in the percent load reduction relative to baseline load. The baseline charging load of the Winter 2022/2023 season was 32% higher than the previous two seasons). As a result, the pilot exceeded its planning

[3] In mid-2023, PGE launched a new one-stop shopping platform called PGE+ to help customers find the right electrical equipment, get it installed, access instant rebates, and enroll in energy-shifting programs for ongoing rewards. The first offering is Level 2 EV chargers. The new application process for the Residential Charging Pilot through PGE+ will be assessed as part of the next evaluation cycle.

[4] Pilot staff launched an installer network in mid-2023 that provides a list of qualified contractors for potential Pilot enrollees to choose from.

assumption for kW load reduction for the first time (0.49 kW relative to 0.45 kW). Both treatment groups had higher percent load reduction relative to baseline load during the Summer 2022 Event Season than the two winter seasons (82% compared to 74%), but more seasons will be needed to confirm the greater relative performance during summer seasons.

- **Recommendation:** As EV ownership increases, the driving patterns and charging needs of EV owners are likely to change. PGE should continue to monitor unmanaged charging baseline load through a randomly assigned control group to support distribution system planning. Continued research into charging load shapes and seasonal differences in managed charging performance will also allow PGE to tailor its managed charging interventions to support system needs.

Evaluability of evPulse: We conducted an equivalency analysis to determine if the control group created through the EVSE channel (Group A) was a good match for EVSE Groups B and C, as well as evPulse Group B. We compared the treatment groups to the control group on key characteristics such as TOD rate enrollment, other pilot enrollment, number of EVs, type of EV, as well as their non-event day charging patterns (weekends). This analysis showed that Group A is a good baseline for the EVSE Groups B and C but is not equivalent to evPulse. We provide estimates of EVSE channel load impacts using a fixed effects model in the body of the report. We provide estimates of charging load impacts for evPulse participants in Appendix A calculated as the straight differences between Group A and evPulse, but we do not have confidence in these results.

- **Recommendation:** To make the evPulse channel evaluable, the pilot should consider implementing one of the following design strategies:
  - Create a control group for the evPulse channel by randomly assigning a share of participants to the group upon enrollment, or
  - Withhold all charging interventions for all new evPulse enrollees for at least 30 days to establish a baseline.
- From an evaluation perspective, the control group approach is preferable because we can more easily control for seasonal differences in charging demand. Because all evPulse enrollees are assigned to Group B, which overlaps with the TOD peak rate period, we expect lower pilot impacts for TOD enrollees.

Event Opt-Outs: While the Residential Charging Pilot shifted a large amount of load relative to the baseline for all treatment groups, a small percentage of charging still took place during the pilot's event windows**.** The evaluation team defined event opt-outs as participants with greater than zero consumption during at least one hour of their PGE event window. Due to data limitations, we were unable to determine whether instances of event nonperformance were due to technology and event execution issues or customer behavior. Opting out (i.e., charging during a participant's event window) is not common. A majority of participants never or rarely opted out while a small percentage did so frequently. Across all three seasons, between 17% and 18% of participants never opted out of a single event, and between 44% and 55% of participants opted out of less than 10% of all events. A small share of participants—between 14% and 17% depending on the event season—opted out of 20% of event days or more. Group C participants were more likely to opt out, while Group B EVSE participants were least likely.

- **Recommendation:** If PGE would like to understand the reasons for charging during event windows, consider conducting additional research with participants who continually opt-out of events.

I.2.2 BUSINESS CHARGING REBATES PILOT

Pilot Awareness and Marketing: Business Charging Rebates Pilot marketing and outreach activities have been sufficient given the pilot budget, although there may be opportunities to increase participation. In alignment with how the pilot is marketed, participants generally learn about the pilot from PGE staff or the PGE website. The pilot's limited marketing

and outreach activities have resulted in about one-third of PGE's commercial customers being aware of the pilot. Pilot staff noted they have not seen commercial customers come over from other PGE offerings, such as the Fleet Partner Pilot, suggesting an opportunity for more cross-pilot promotion. Further, customer outreach staff indicated a need for additional information and updates about PGE's TE offerings (i.e., Fleet Partner Pilot and Drive Change Fund) to ensure that customers they work with are aware of these offerings.

- **Recommendation:** Ensure that PGE account representatives are aware and knowledgeable of the Business Charging Rebates Pilot to inform commercial customers about the opportunity. Consider providing periodic email updates or presentations to account representatives to inform them about new offerings and updates to existing offerings.

Pilot Participation and Rebate Levels: The Business Charging Rebates Pilot has been successful at increasing participation in 2023 and serving underserved communities. Changes to pilot offerings in 2022 have resulted in increased participation, which has primarily included properties offering mixed-use (i.e., fleet, multifamily, public, and workplace) and public charging options. Further, the pilot has been successful at reaching underserved customers, as most installed chargers are located in underserved communities. Pilot rebate levels appear sufficient to meet current demand but could be adjusted depending on market conditions. As of April 2023, new customers applying to the Business Charging Rebates Pilot could only receive rebates for qualified charging equipment and not for make-ready infrastructure. Customers who had previously reserved a spot in the Pilot can still receive a rebate for make-ready infrastructure in 2024. Most participants are early adopters of EV charging and indicated they would have installed charging without the financial assistance they received from PGE. Since many existing commercial properties require make-ready infrastructure before installing charging, additional make-ready support may be necessary for expanding pilot participation to those less willing or able to pay the full costs of installation.

- **Recommendation:** Continue to offer rebates for chargers, but also consider reinstating financial support for make-ready infrastructure to increase charging access at commercial properties, particularly for those properties serving underserved communities.

Pilot Satisfaction and Participation Challenges: Business Charging Rebates Pilot participants expressed high levels of satisfaction with their experience with the pilot; however, some participants shared concerns about the participation requirements, and some experienced challenges communicating with pilot staff or EVSE vendors. Participants expressed concerns about: the requirement to maintain chargers for 10 years, sharing charging data with PGE, selecting PGE-qualified chargers that would be best suited for their property, and finding an EVSE vendor with sufficient quantities of qualified chargers. Participants also mentioned challenges with communication, particularly obtaining PGE assistance with the application process and inconsistent communication from charging vendors. In 2023, the pilot introduced a new online application portal to make it easier for participants to apply and submit supporting documentation.

- **Recommendation:** Consider offering additional technical assistance to commercial customers to ease the process of selecting and procuring chargers. In the 2024 evaluation, continue to monitor participant satisfaction to see if changes to the application portal have improved customer satisfaction.

Charger Energy Consumption and Utilization: Business Charging Rebates Pilot charger energy consumption has increased steadily throughout the study period as the number of charging ports increased, peaking at 23 MWh in June 2023.[5] Both charger energy consumption and utilization appear to vary considerably by site use (i.e., fleet, multifamily, public, and workplace charging). Due to the relatively small number of sites with available charging data (n=33), differences in energy consumption and utilization may be due to the charging of specific pilot participants rather than trends in site types. In terms of energy consumption, sites used for fleets, workplace, and mixed usage generally have

[5] The study period includes charging data from January 2021 through the end of August 2023.

peaks during working hours, while public and multifamily sites appear to be more evenly distributed throughout the day. Further, sites used for fleet charging had significantly higher port utilization rates compared to other site uses.

- **Recommendation:** Evaluation results suggest variations in charging behaviors by site use. PGE should continue to monitor charger energy consumption and utilization as more Business Charging sites come online to better establish baseline charging metrics by site use. Pilot participant research in 2024 should also explore how charger use varies by site type and the reasons for variation. Findings from this research can help inform the design of future managed charging offerings for commercial customers.

I.2.3 FLEET PARTNER PILOT

Pilot Awareness and Marketing: Leveraging PGE staff's knowledge and existing relationships with customers to promote the Fleet Partner Pilot has been effective at generating awareness. Most projects supported by the pilot were initiated by PGE staff, with few customers reaching out directly to PGE to inquire about electrification offerings. Even though pilot outreach efforts were paused in late 2022, Key Customer Managers (KCMs) and business outreach staff mentioned challenges with staying up to date on current TE offerings and suggested better coordination between KCMs and pilot staff, so KCMs can better assist with the application and enrollment process.

- **Recommendation 1:** Continue providing regular updates to KCMs and business outreach staff about current TE offerings and updates on program requirements and incentive levels. Because KCMs and business outreach staff have established relationships with customers, consider closer coordination during the participation process, including involving staff in project kickoff meetings and providing project status email updates.
- **Recommendation 2:** If additional funding becomes available, PGE could consider exploring alternative ways of engaging with fleets in its service territory. This could include connecting with fleet managers through resources that fleet managers report using, including online fleet management resources, industry publications, conferences and expos, and social media (i.e., LinkedIn).

Pilot Requirements: The Fleet Partner Pilot's new load and easement requirements were challenging for participants. Fleet managers recalled that meeting the minimum 70 kW of new load requirement was not possible, leading some managers to withdraw their participation. An additional pilot requirement that posed a challenge for some participants was signing property easements for the make-ready infrastructure. Participants had concerns about the liabilities to the property owners for signing the easement, some of whom experienced significant delays due to prolonged negotiations between PGE's legal team and customers' landlords to address those concerns.

- **Recommendation 1:** Since the Fleet Partner Pilot is targeted towards larger customers, PGE may want to consider developing additional offerings to customers with smaller fleets. In the meantime, direct customers with smaller fleets to the Business Charging Rebates Pilot through additional marketing and coordination with business outreach staff and KCMs.
- **Recommendation 2:** Consider providing additional information to potential participants about the easement requirement, highlighting the importance of the easement in PGE's ability to maintain the make-ready infrastructure. As the easement process can result in lengthy legal reviews, ensure the process starts early to limit impacts on project timelines. Customers who are not the property owners may require additional assistance to obtain easements from the property owners.

Pilot Funding and Project Timelines: Fleet Partner Pilot staff mentioned two key challenges that the pilot faced in 2023: a shortfall in available funding and supply chain issues. By January 2023, funding for make-ready build-out was exhausted, leading to some customer frustration. Funding has since been reinstated, with reductions in incentive levels. Additionally, staff mentioned challenges with extended delays in procuring equipment, including transformers and

switchgear, leading to elongated project timelines. Interviewed build phase participants echoed this, mentioning that completion dates were set back for up to six months due to supply chain issues. Pilot staff have worked to address this issue by ordering equipment ahead of time to limit the impact on project timelines.

- **Recommendation:** Most utilities do not have control over the procurement schedule for customer project components. As a best practice, some utilities have started to keep an inventory of residential and commercial project components to mitigate the risks of significant delays to project timelines. In addition to ordering equipment well in advance, PGE could consider stockpiling critical project equipment to further decrease project timelines.

Technical Assistance and Total Cost of Ownership (TCO) tool: Fleet Partner Pilot participants expressed high levels of satisfaction with their experience with the pilot; however, some suggested a need for additional technical support and tools. Additional technical support suggested included additional detail on results from the charging, fuel cost, and energy use analysis, and assistance in determining the optimal number of chargers needed for their fleet. PGE's Total TCO tool is a free fleet planning tool that provides initial fleet analysis, including costs, energy use, and chargers needed. Several fleet managers reported using PGE's TCO tool and generally found it useful but desired additional features that capture demand charges and how projected energy usage may impact their monthly bills. Additionally, some fleet managers who used the TCO tool noted that cost estimates they received in their Fleet Study deviated from estimates they received from the TCO tool. They speculated that the deviations may have been a result of the TCO tool not accounting for all the potential factors that determine costs, including the impacts of ongoing inflation and labor costs.

- **Recommendation**: To the extent possible, ensure the online TCO tool accurately accounts for all factors associated with fleet electrification costs. When there are significant deviations between the TCO tool and preliminary costs in the Fleet Study, ensure that participants understand the reasons for the deviations.

Charger Energy Consumption and Utilization: During the study period, only three Fleet Partner Pilot participant sites consisting of 17 chargers had available charging data. Charger energy consumption for these three sites peaked at 1,039 kWh in August 2023. The load factor of charging across all sites also increased throughout the study period but remained relatively low. Charger utilization at participant sites was generally low, ranging from 2%–4%.

- **Recommendation:** PGE should continue to monitor charger energy consumption and utilization as more Fleet Partner Pilot sites come online to better establish baseline charging metrics.

2. INTRODUCTION

2.1 BACKGROUND

PGE has been working towards promoting greater electrification of the transportation sector by developing and implementing a wide range of programs. These programs are designed to cater to the needs of residential customers (single and multifamily), private and public fleet operators, municipalities, and businesses. In late 2018, PGE launched a coordinated set of pilot programs focused on customer outreach and education about EVs and charging called the Outreach, Education, and Technical Assistance Pilot. Additionally, PGE expanded public charging infrastructure through its Electric Avenue Pilot and electrified mass transit through its Electric Mass Transit 2.0 Pilot. Based on learnings from these initial three Pilots and other research conducted by PGE, PGE introduced three new pilots starting in 2020: Residential EV Smart Charging ("Residential Charging"), Business EV Charging Rebates ("Business Charging"), and Fleet Partner. Together, these Pilots contribute to a transportation ecosystem, where:

- Charging is accessible and adequate, reliable, affordable, and equitable;
- Businesses, organizations, and municipalities can achieve their emissions goals through electrification;
- EVs are efficiently integrated into the electrical grid, minimizing growth in system peak energy requirements; and,
- Electric mobility is available to all including historically underserved communities.

The following sections provide a summary of each Pilot along with their respective objectives and key activities.

2.1.1 RESIDENTIAL CHARGING PILOT

PGE launched its Residential Charging Pilot in 2020, with the first event season starting in October 2021. The pilot's objective is to shift EV charging away from peak times when energy use is high and sustainable energy sources are scarcer. In exchange for rebates for Level 2 EV supply equipment (EVSE/chargers) and the opportunity to earn a seasonal electric bill credit, Pilot participants allow PGE to control their EV charging during defined event hours.[6] The pilot stops charging during these event hours on every non-holiday, weekday of each season. The winter season runs from October to March and the summer season from April to September. Enrolled customers are eligible for a $25 seasonal bill credit by participating in events.[7] In addition to EVSE rebates, the Residential Charging Pilot also provides rebates to customers who require upgrades to their electrical panel to install Level 2 chargers.[8]

Table 3 shows key Pilot design features. Participants are assigned to one of three groups. Participants in Group A, the control group, do not have their EV charging curtailed on event days. The pilot design has two different event time windows. Group B participants have their charging curtailed from 5:00 p.m. to 8:00 p.m. on event days and Group C has their charging curtailed from 10:00 p.m. to 11:59 p.m. on event days.

Group B is further divided into two subgroups, based on the charging control technology used by the participants. EV drivers can participate in the pilot through a qualified networked (Wi-Fi®-connected) Level 2 charger or through vehicle

[6] Customers received a $500 rebate ($1,000 for income-eligible customers) for the purchase and installation of a qualified Level 2 charger at their home. The non-income-eligible charger rebate amount decreased to $300 in October 2023. Customers who purchase and install a Level 2 charger prior to it being added to PGE's Qualified Products List can receive a $50 rebate. Customers that drive a qualified vehicle but have a non-qualified EV charger can enroll to the pilot through vehicle telematics (evPulse) and receive a $50 rebate.

[7] To be eligible for the seasonal bill credit, customers must have their charger connected to the internet 50% of the time, charge their vehicles at least 13 times a season, and participate in at least 3 events during a season.

[8] Customers who apply for the standard rebate can receive up to $1,000 and income-eligible customers can apply to receive up to $5,000 towards the cost of their panel upgrade.

telematics (the vehicle's onboard communication system). Qualified EVSE manufacturers for participating drivers include ChargePoint, FLO, and Enel X. Customers with qualified chargers are randomly assigned to Groups A, B, or C. Most Tesla owners have a Tesla charger and are not eligible to participate using their chargers. Instead, Tesla owners participate via onboard vehicle telematics using WeaveGrid's software product, evPulse.[9] All Tesla owners who participate via evPulse are assigned to Group B.[10]

Pilot participants can also participate in other PGE programs that encourage them to shift their usage to times of the day with less demand. The residential TOD time varying pricing plan has three pricing periods, with the highest rate during the on-peak period from 5 p.m. to 9 p.m., a mid-peak period that runs from 7:00 a.m. to 5:00 p.m., and an off-peak period that runs from 9 p.m. to 7 a.m. The Peak Time Rebates (PTR) Pilot is a behavioral demand response program that pays customers to reduce their electric use over several hours on select days. The PTR summer season runs from June 1 through September 30 and the winter season runs from November 1 through February 28. PTR events can last from two to five consecutive hours and can occur between 7:00 a.m. and 11:00 a.m. or 3:00 p.m. to 8:00 p.m. during non-holidays. Upon enrollment, the pilot assigns EVSE channel customers who also participate in TOD and/or PTR to Groups A or C to avoid overlap with the Residential Charging Pilot event window. Because all evPulse participants are assigned to Group B, there is an overlap between event windows for participants who also participate in TOD and/or PTR. Participants who are on the TOD rate could have less curtailable EV charging load during Group B's event window, limiting the potential impacts of the Residential Charging Pilot.

Table 3. PGE Residential Charging Pilot Design

Group	Channel	Event Hours	Additional Pilot Participation
A (Control)	EVSE	NA	TOD/PTR
B	EVSE	5:00 p.m. – 8:00 p.m.	NA
B	evPulse Vehicle Telematics	5:00 p.m. – 8:00 p.m.	TOD/PTR
C	EVSE	10:00 p.m. – 11:59 p.m.	TOD/PTR

2.1.2 BUSINESS CHARGING REBATES PILOT

PGE launched its Business Charging Rebates Pilot in 2020 with the objective of accelerating EV adoption by ensuring adequate charging infrastructure is available to meet commercial customers' charging needs, reducing the cost and complexity of installing EVSE, and creating a network of demand response (DR)-enabled EVSEs to support efficient grid operations and future integration of renewables. The pilot program was introduced with a standard rebate to commercial customers of $500 per Level 2 port, which later was increased to $1,000 per port in July 2021. Additionally, an income-qualified multifamily rebate of $2,300 per port was introduced, which was extended to all multifamily sites in November 2022. In November 2022, the pilot expanded to also include make-ready installation rebates and rebates for direct current fast chargers (DCFCs) up until April 2023, when funding for these rebates was fully reserved. In exchange for the rebate, customers agree to keep the EVSE operational and on a PGE cost-of-service rate for a period of 10 years, as well as release the charger data to PGE for analysis and reporting purposes.

2.1.3 FLEET PARTNER PILOT

PGE launched its Fleet Partner Pilot in 2021. There are multiple objectives of this Pilot, namely, to reduce costs and complexities for managers of nonresidential fleets who are interested in transitioning to electric fuel. Additionally, there

[9] All product or company names that may be mentioned in this publication are tradenames, trademarks, or registered trademarks of their respective owners.

[10] PGE cannot confirm the original rational for this approach due to staff departures. PGE recognizes the groups are not ideal for evaluating performance and is working to address for future evaluations.

is an aim to create a network of DR-enabled EVSEs that can support efficient grid operations and future renewables integration. There are two participation phases of the Fleet Partner Pilot:

- **Fleet Partner Plan Phase:** Includes EV feasibility assessments, vehicle operations and charging analyses, fuel cost and clean fuel credit analyses, site walkthroughs, design and cost estimates, and incentive summary delivered in a comprehensive Fleet Partner Study.
- **Fleet Partner Build Phase:** Fleet customers who complete a Fleet Partner Study can join the reservation list for the Build phase, which includes turnkey final design, construction of make-ready infrastructure, incentives, and PGE ownership of make-ready infrastructure.

In the pilot, PGE covers up to $750,000 depending on the customer's energy commitment. Charging site(s) must be in PGE service area and fleet customers are responsible for charger costs, annual maintenance costs, electricity costs, and any make-ready costs not covered by the custom cost incentive. The pilot requires a make-ready design of at least 70 kW of connected load, and that participants share charging data with PGE for 10 years, commit to the forecasted energy use of the chargers, and sign an easement covering PGE-owned infrastructure, as well as agree to terms of Participation Agreement.

2.2 EVALUATION OBJECTIVES AND ACTIVITIES

This evaluation report covers pilot activities running from each pilot's inception through the second quarter of 2023. Results are reported for evaluation activities conducted between April 2023 to October 2023. Primary data collection activities conducted in 2023 included interviews with pilot staff and partners, a post-event survey to Residential Charging Pilot participants, interviews with Business Charging Rebates Pilot participants, surveys with Fleet Partner Plan phase participants, and interviews with Fleet Partner Build participants.[11] In addition to primary data collection, the evaluation team also conducted impact analyses that included residential load impacts, commercial and residential charging pattern analyses, and Pilot participation analysis. The participation analysis was similar across Pilots and used Pilot participation data to assess the demographics and firmographics of Pilot participants, the timing of sign-ups in relation to the marketing activities to assess marketing effectiveness, and, using PGE-provided GIS shapefiles, determining how many Pilot participants are located in underserved communities as defined by Oregon House Bill 2165 (HB2165).[12] The following sections provide details on primary data collection and impact analysis conducted in 2023.

We will submit a second evaluation report in November 2024. The report will cover Residential Charging Pilot activities conducted during the Summer 2023 and the Winter 2023/2024 event seasons. For the Business Charging Rebates Pilot and Fleet Parter Pilot, the 2024 report will cover pilot activities conducted from the third quarter of 2023 through the second quarter of 2024. Evaluation activities will include two additional waves of a post-event survey with Residential Charging Pilot participants, surveys with Business Charging Pilot participants, surveys with Fleet Partner Plan phase participants, and interviews with Fleet Partner Build participants, in addition to residential and commercial charging impact analyses.

[11] This report only includes results from one of the two waves of residential post-event surveys in 2023. At the time of this report, the 2nd wave of the post-event survey was being fielded. Results from that survey will be included in the 2024 evaluation report.

[12] Underserved communities are defined by HB2165 and include census tracts that contain high proportions of renters, multifamily housing, communities of color, low-income households, tribal communities, rural communities, and other communities adversely harmed by environmental health hazards. PGE developed GIS shapefiles that identified census tracts with high proportions of each of the above criteria, which the evaluation team used to flag Pilot participants who met at least one of the criteria.

2.2.1 RESIDENTIAL CHARGING PILOT

PROCESS ANALYSIS

The process analysis for the Residential Charging Pilot leveraged the following primary data collection activities:

- In-depth interviews with PGE staff involved with the pilot and implementation partners.
- Online post-event surveys with Winter 2022/2023 Event Season participants.

The evaluation team conducted an in-depth interview with PGE program staff in April 2023 to discuss key aspects of pilot implementation and identify priorities for upcoming research efforts and future pilot offerings. We then met with PGE's marketing specialist in May 2023 to learn more about pilot outreach and recruitment efforts, and in June 2023 we met with staff from implementation partners involved in operating each channel of the Residential Charging Pilot. These implementer interviews included a conversation with WeaveGrid to better understand the operation of the evPulse channel, including its charging optimization component, and the availability of charging data for evPulse participants. We also spoke to Generac staff about their role in registering, facilitating, and tracking EVSE channel participation.

Conversations with program staff and implementation partners helped inform the development of a post-event survey, which we fielded with a sample of Winter 2022/2023 season participants. The survey solicited customers' feedback regarding their experiences with all stages of enrollment and participation in the pilot, their EV charging habits, and the pilot's influence on charging behavior. The survey covered the following topics:

- Awareness of pilot marketing and outreach activities;
- Satisfaction with the participation processes and outreach efforts;
- Awareness of and satisfaction with pilot communication during the event season;
- Challenges with participation in DR events;
- Experience using EV charging mobile and web applications;
- Influence of the pilot on charging behaviors and patterns;
- Reasons for overriding or opting out of events;
- Awareness of qualification requirements for seasonal incentives; and
- Satisfaction with seasonal incentive award and accuracy of qualification tracking.

We attempted a census of all participants in the Winter 2022/2023 Event Season, including both the EVSE and evPulse channels and from the treatment and control groups.[13] To minimize participant recall issues, we fielded the survey in the months immediately following delivery of Winter 2022/2023 Event Season bill credits. We reached out via email, contacting each participant up to three times between July and August 2023, inviting them to complete an online survey. The sample included 2,524 pilot participants (after excluding duplicate accounts and records with incomplete information for sampling purposes), 944 of whom completed the survey for a yield of 37% and a response rate of 39%. The distribution of completes across channels and groups is representative of the overall population (the relative contribution of each channel/group to completes is within 5% of their respective contribution to the population). Table 4 summarizes the number of participants included in the sample and the number of survey completions by channel and group.

[13] As part of survey sample development, we excluded a small number of records to omit duplicate contacts, participants who unenrolled prior to the end of the event season, and those with inconsistent or missing group membership.

Table 4. Residential Charging Pilot Post-Event Survey Fielding Summary

Channel	Group	Sample	Completes	Yield
EVSE	A (Control)	393	177	45%
	B (5:00 p.m. – 8:00 p.m.)	372	143	38%
	C (10:00 p.m. – 11:59 p.m.)	630	257	41%
evPulse	B (5:00 p.m. – 8:00 p.m.)	1,129	367	33%
Total		**2,524**	**944[a]**	**37%**

[a] Includes 67 partially completed surveys that were included in our analysis.

IMPACT ANALYSIS

The overarching objectives of the impact analysis of the Residential Charging Pilot are to estimate the impact of the pilot on shifting EV charging load and explore the drivers of event performance for the Winter 2021/2022, Summer 2022, and Winter 2022/2023 Event Seasons. We also examined charging patterns of pilot participants through the construction of charging load shapes. Specifically, our analysis provides information about:

- Average per vehicle/charger and overall pilot event hour load impacts;
- Hourly degradation within events;
- Frequency of charging during events (opt outs);
- Average hourly electricity consumption over a 24-hour period by weekday, weekend, and season;
- Variations in load across key characteristics (i.e., TOD, group, home vs. away-from-home charging, etc.); and
- Aggregated on-peak and non-coincident peak consumption.

We utilized participant data provided by PGE, including enrollment and de-enrollment records for vehicles and chargers starting in 2020. For the load impact and charging pattern analysis, we leveraged two distinct pathways—EVSE charger telemetry interval data from Generac for ChargePoint, FLO, and Enel X EVSEs, and charging telemetry interval data from WeaveGrid for evPulse participants. The dataset from WeaveGrid included additional variables from the vehicle telematics system including vehicle identification and plug location (a flag for whether the vehicle was charging at home or away from the owner's residential address).

The available data had several limitations. The EVSE charger telemetry data were missing for Group A for October 2021, and as a result, we excluded October 2021 from the impact analysis. Additionally, there were other missing data across groups (usually the last few days or hours of a month). We determined that this small amount of missing data did not greatly impact results and used the data available for each period when modeling savings and charging patterns.

We conducted a thorough review, cleaning, and preparation of the data for analysis (see Appendix A for details). After data cleaning and preparation, we created and examined charging load shapes and patterns of pilot participants. We assessed key differences in charging patterns between unmanaged charging, represented by the pilot's control group (Group A) and managed charging for each of the treatment groups (Groups B and C). We also identified charging differences by enrollment channel (EVSE and evPulse), participation in other PGE programs (TOD and PTR), event season, different vehicle types, and other key segments.

Before estimating program impacts, we conducted an equivalency analysis to determine if the control group created through the EVSE channel (Group A) was a good match for EVSE Groups B and C as well as evPulse Group B. We compared the treatment groups to the control group on key characteristics such as TOD rate enrollment, other pilot

enrollment, number of EVs, type of EV, as well as their non-event day charging patterns (weekends). This analysis showed that Group A is a good baseline for the EVSE Groups B and C but is not equivalent to evPulse.[14]

We used a fixed effects model to estimate kW load reduction due to the pilot for the EVSE channel. We excluded evPulse from the modeled results due to inequivalence with the control group (Group A) but provide alternative results calculated as simple differences between the treatment and control groups in Appendix A for all groups and enrollment channels, including evPulse.

We conducted additional analyses to understand the prevalence of event opt-outs to better understand event performance. We defined an event opt-out as participants that have greater than zero consumption during at least one hour of their PGE event window. For evPulse, away charging is excluded from this exploration since charging is not curtailed when the vehicle is not at home. We received hourly data for the EVSE channel and 15-minute data for evPulse. Given the level of data aggregation, we could not identify customers who charged for just a few minutes. Due to data quality issues with the provided charger connectivity reports, we could not determine whether charging during an event window was due to customer behavior or technological failure.

Additional details about our data cleaning and preparation process, equivalency analysis, opt-out analysis, and load impact and charging pattern analysis methodology can be found in Appendix A.

2.2.2 BUSINESS CHARGING REBATES PILOT

PROCESS ANALYSIS

The process analysis for the Business Charging Rebates Pilot leveraged the following primary data collection activities:

- In-depth interviews with PGE staff involved with the pilot
- In-depth interviews with participants who received rebates through the pilot

Three in-depth interviews with PGE staff who were involved with the Business Charging Rebates Pilot were conducted between April and May 2023. The interviewed staff included the product manager, marketing personnel, Key Customer Managers (KCMs), and business outreach personnel. The main objective of these interviews was to gather comprehensive details about pilot implementation, successes, challenges, expected outcomes, and suggestions for improvement.

Between August and September 2023, additional in-depth interviews were conducted with participants who received rebates through the pilot. The purpose of these interviews was to gather information about participants' businesses and their motivations for installing EV charging, document any challenges faced during the procurement and installation of chargers, and assess their level of satisfaction with the pilot program. The interviews covered the following topics:

- How participants learned about the pilot;
- The role that the pilot had on the decision to install EV charging;
- Satisfaction with the pilot process and support services provided;
- Details about the EV charging setup, including types of users and payment structure; and
- Financial costs and benefits of having installed EV charging and operational challenges.

The 25 organizations that received rebates through the pilot between August 2021 and July 2023 had email requests sent to them to complete their interview. Non-responders to email outreach were contacted via phone. In total, the

[14] PGE recognizes the groups are not ideal for evaluating performance and is working to address for future evaluations.

evaluation team completed 10 interviews resulting in a 40% response rate (Table 5). All interviewees were offered a $50 incentive for completing the interview.

Table 5. Business Charging Rebates Pilot Participant Interview Dispositions

Disposition	Count
Completed interview	10
No response	12
Refusal	3
Total	**25**

IMPACT ANALYSIS

The overarching objective of the impact analysis of the Business Charging Rebates Pilot is to provide PGE with information about EV charging patterns so it can plan for system impacts from EV load growth and develop appropriate load management strategies. Specifically, our analysis provides information about:

- Average hourly electricity consumption;
- Total electricity consumption during study period;
- Aggregated on-peak and non-coincident peak consumption;
- Variation in energy consumption by customer segment; and
- Charging port utilization rates.

The Business Charging Rebates Pilot impact analysis leveraged charging data from commercial customers and charging vendors compiled in PGE's non-residential charger database to develop key charging metrics and average aggregate load curves of participants.[15] The analyses required both session and interval data, but only session data were initially available. Therefore, PGE created interval data from the session data, which was verified by the evaluation team. The Business Charging Rebates Pilot impact analysis covers from January 1, 2021, through the end of the reporting period (August 31, 2023).

The available data had some limitations. PGE staff shared that one vendor was unable to provide charging start and end times for charging sessions but was able to provide plug start and end time as well as charging duration. PGE staff reconciled this limitation by determining that missing charging start times should be filled in using plug start time. Further, charging end time should be calculated by adding the charge duration to the new charge start time. This approach assumes that charging begins as soon as a vehicle is plugged in, which may not always be the case due to driver preferences programmed into the vehicle or charging issues. Given that it is non-residential charging, PGE staff felt comfortable making the assumption that charging would begin as soon as the vehicle is plugged in. The charging start and charging end times were used by PGE staff to generate the time series data used in analyses.

Additional details about the data cleaning and preparation process used, as well as detailed load impact and charging pattern analysis methodology, can be found in Appendix B.

[15] PGE's charger database and online charger registration form were developed in early 2023. For chargers installed prior to 2023, either the customer registered the chargers in 2023 and listed an earlier install date, or charger information was collected using program information (i.e., Business Charging Rebate applications). Once chargers were added to the database, PGE worked with those charging vendors to collect charging session data. For some vendors, it took several months until they were able to start consistently sending session data, and any data prior to that point is not available. Other vendors were able to provide session data back to when the charger was first installed.

2.2.3 FLEET PARTNER PILOT

PROCESS ANALYSIS

The process analysis for the Fleet Partner Pilot leveraged the following primary data collection activities:

- In-depth interviews with PGE staff involved with the pilot;
- In-depth interviews with fleet managers who inquired about and applied for the Fleet Partner Pilot, but later withdrew their application;
- Online surveys with fleet managers who completed the Plan phase of the pilot; and
- In-depth interviews with fleet managers who completed the Build phase of the pilot.

The evaluation team completed interviews with eight staff and implementers involved with the Fleet Partner Pilot between April and May 2023. The main objective of these interviews was to gather insights into pilot implementation, successes, challenges, expected outcomes, and suggestions for improvement. The product manager, KCMs, engineering, marketing, and business outreach staff were interviewed.

In May of 2023, the evaluation team conducted in-depth interviews with fleet managers who inquired about and applied for the Fleet Partner Pilot, but who later withdrew their application. The interviews with inactive participants included questions about pilot marketing efforts, reasons for withdrawing from the pilot, participation challenges that PGE could address, the appropriateness of the custom incentive for make-ready infrastructure, and the usefulness of the online Total Cost of Ownership (TCO) planning tool. Interviewees were recruited via email from a PGE-provided list of five contacts who withdrew from the pilot (detailed findings from those interviews can be found in Appendix D). All inactive participant interviewees were offered a $100 incentive for completing the interview.

Between August and September 2023, the evaluation team conducted online surveys with fleet managers who completed the Plan phase of the pilot and conducted in-depth interviews with those who completed the Build phase of the pilot. The objectives of the surveys and interviews were to document how participants learned about the pilot, the effectiveness of technical assistance received from PGE staff, challenges encountered with participating in the pilot, interest in future managed charging offerings, and satisfaction with the pilot. Survey and interview respondents were recruited via email from a PGE-provided list of 37 participants who completed the Fleet Plan phase and six participants who completed the Fleet Build phase. In total, nine Plan surveys and four Build interviews were completed, resulting in a 24% and 67% response rate, respectively (Table 6). All respondents and interviewees were offered a $50 incentive.

Table 6: Fleet Partner Pilot Participant Interview and Survey Dispositions

Disposition	Inactive Participant Interviews	Participant Survey (Plan Phase)	Participant Interviews (Build Phase)
Completed	4	9	4
No response	1	19	2
Undeliverable emails	0	3	0
Began Build Phase (to be interviewed in 2024)[a]	0	4	0
Refusal	0	2	0
Total	**5**	**37**	**6**

[a] Four pilot participants indicated they have moved on to the Build phase of the pilot and were exited from the survey. We plan to interview these participants in 2024 as part of our second wave of Fleet Partner Build interviews.

IMPACT ANALYSIS

Similar to the Business Charging Rebates Pilot, the overarching objective of the impact analysis of the Fleet Partner Pilot is to provide PGE with information about EV charging patterns so it can plan for system impacts from EV load growth and develop appropriate load management strategies. Specifically, the impact analysis provides information about:

- Average hourly electricity consumption;
- Total electricity consumption during study period;
- Aggregated on-peak and non-coincident peak consumption;
- Variation in energy consumption by customer segment; and
- Charging port utilization rates.

The Fleet Partner Pilot impact analysis leveraged charging data from PGE's non-residential charger database to develop key charging metrics and average aggregate load curves of participants. The analysis required both session and interval data, but only session data were initially available. Therefore, PGE created interval data from the session data which was verified by the evaluation team. The Fleet Partner analysis covers from June 6, 2023, through the end of the reporting period (August 31, 2023).

Additional details about the data cleaning and preparation process, in addition to detailed load impact and charging pattern analysis methodology, can be found in Appendix C.

3. RESIDENTIAL CHARGING PILOT FINDINGS

The following section provides detailed results of the Residential Charging Pilot post-event survey and charging load impact and pattern analyses. The period under evaluation covers three event seasons, running from the launch of the program in October 2020 through March 31, 2023 (i.e., the Winter 2021/2022, Summer 2022, and the Winter 2022/2023 Event Seasons). The post-event survey focused on participation during the Winter 2022/2023 Event Season.

3.1 PILOT PARTICIPANT CHARACTERISTICS

Customer enrollment in both the EVSE and evPulse channels of the Residential Charging Pilot has been strong. The pilot began enrolling participants on an ongoing basis into the EVSE channel in late 2020 and the evPulse channel enrollment began in late 2021.[16] During the Winter 2022/2023 Event Season, 2,717 chargers/vehicles were enrolled in the pilot across the two channels (Table 7). This is nearly double the enrollment from the Summer 2022 season and 150% increase from the pilot's first season (Winter 2021/2022).

Participation in the EVSE channel grew steadily, increasing 63% between the Winter 2021/2022 and Summer 2022 Event Seasons, and another 52% between the Summer 2022 and Winter 2022/2023 Event Seasons. Overall, the number of participants in the EVSE channel increased by 147% from 581 participants in the Winter 2021/2022 Event Season to 1,435 participants a year later. A total of 49 EVSE participants unenrolled from the pilot across the three event seasons.

Tesla drivers already participating in the Smart Grid Test Bed (Phase I) were enrolled into the evPulse channel in November 2021, quickly reaching the initial channel cap of 500 participants by the end of February 2022 (just three months after opening for enrollment), at which point enrollment halted until Q4 2022.[17] With no new enrollments during most of 2022, evPulse enrollment dropped slightly between the Winter 2021/2022 and Summer 2022 Event Seasons. When enrollment opened to customers outside of the Smart Grid Test Bed, enrollment increased by 179%, reaching 1,282 participants for the Summer 2022 Event Season. A total of 52 evPulse participants unenrolled from the pilot across the three event seasons.

Table 7. Residential Charging Pilot Participant Enrollment Trends

Metric	Winter 2021/2022	Summer 2022	Winter 2022/2023
Total			
Total participant count	1,084	1,407	2,717
Percent increase in participant season-over-season		+30%	+93%
EVSE			
Total participant count	581	947	1,435
Percent increase in participant season-over-season		+63%	+52%
evPulse			
Total participant count	503	460	1,282
Percent increase in participant season-over-season		-9%	+179%

[16] For the EVSE channel, a participant is an enrolled charger. Customers could enroll more than one charger; however, fewer than ten customers did so over three event seasons. For evPulse, a participant is an enrolled vehicle. Approximately 7% of accounts, enrolled more than one Tesla in evPulse.

[17] The Pilot did not expand evPulse enrollment to the full PGE service area until the Schedule 8 tariff was updated. PGE maintained a waiting list of interested customers to enroll after the tariff update.

The Residential Charging Pilot met its 2023 annual cumulative enrollment targets for unique chargers/vehicles (Table 8). With the pace of enrollment increasing since the cap on evPulse enrollment was lifted, the pilot has an opportunity to reach its 2024 enrollment goals as well.

Table 8. Residential Charging Pilot Participant Enrollment Compared to Goals

Year End	Cumulative Enrollment	Goal
2020	11	100
2021	482	1,550
2022	2,279	3,393
2023	4,529	4,200
2024	--	7,500

Source: Cumulative enrollment for 2020 through 2022 based on evaluation team analysis of PGE enrollment data, 2023 cumulative enrollment and goals provided by PGE pilot staff.

As part of the participation analysis, Opinion Dynamics examined data from the participant tracking data across the Winter 2021/2022, Summer 2022, and Winter 2022/2023 Event Seasons. We examined results from the Winter 2022/2023 post-event participant survey for characteristics not collected during participant enrollment or those that were not well-populated in the database. We present the key findings on participant composition trends from the program tracking data (Table 9) and the participant survey (Table 10) below.

Most EVSE participants received the standard charger rebate, and a small share of participants received the income-eligible charger rebate. The rebate mix remained largely unchanged over time. EVSE channel participants could qualify for one of several available charger rebates, dependent on income-eligibility and the model of their Level 2 smart charger.[18] Approximately 90% of all EVSE channel participants received standard charger rebates of up to $500 for installing a qualifying Level 2 smart charger and 8% qualified for income-eligible charger rebates of up to $1,000 (Table 9).[19] Another 2% received a $50 rebate for the purchase and installation of a Level 2 smart charger that was added to the qualified product list after it was already installed, referred to as Bring Your Own Charger (BYOC). The rebate mix remained largely unchanged over time. Beginning in November 2022, customers who received a charger rebate could qualify for an additional panel upgrade rebate if installation of a qualified Level 2 smart charger necessitated an upgrade to their home's electrical panel. In the first few months of the offering, seven non-income-eligible customers qualified for the $1,000 standard panel upgrade rebate, and two qualified for the income-eligible rebate of up to $5,000.

Enrollment in the TOD rate was high and steady among evPulse participants. TOD rate enrollment increased dramatically among the EVSE participants. Slightly under half of evPulse participants were enrolled in the TOD rate across all seasons (43% during the Winter 2021/2022 and Summer 2022 Event Seasons and 46% during the Winter 2022/2023 Event Season) (Table 9). TOD rate enrollment increased among the EVSE participants from 18% during the Winter 2021/2022 Event Season to 42% during the Winter 2022/2023 Event Season. Such a high share of TOD rate enrollment is not surprising, given that PGE was cross-promoting the TOD rate enrollment alongside the Residential Charging Pilot. Because the TOD rate intends to permanently shift load, rate enrollment could impact charging behaviors, and by extension, Residential Charging Pilot load impacts. We explore these effects in subsequent report sections.

Cross-enrollment in the PTR Pilot decreased over the course of the three event seasons for both the EVSE and evPulse channels. Between 12% and 20% of Residential Charging participants were also enrolled in the PTR Pilot, depending on

[18] Income eligibility was defined as 80% or less of state median income prior to November 2022, at which point the threshold changed to 120% to align with the HB2165 underserved community income definition.

[19] As of October 18, 2023, standard charger rebates have been reduced from $500 to $300. This change was made after the current evaluation period.

the event season (Table 9). Roughly 14% of all PGE's residential customers are enrolled in the PTR Pilot. Three Peak Time Rebate events were called during the Winter 2021/2022 Event Season, six during the Summer 2022 Event Season, and four during the Winter 2022/2023 Event Season. Participant charging behavior during event hours can differ in response to the PTR event signal and, therefore, impact the effectiveness of the Residential Charging Pilot on those event days. Given the small number of event days, we were able to exclude PTR event days from the impact analysis entirely, to more clearly isolate the impacts of the Residential Charging Pilot.

Approximately two-thirds of EVSE channel participants drive a battery electric vehicle (BEV) as opposed to a plug-in hybrid electric vehicle (PHEV) as their primary EV. The mix of BEVs versus PHEVs stayed roughly the same over the three event seasons (66% to 68% depending on the season) (Table 9). For the EVSE channel, the program tracking data contained information on the primary EV in the household. According to survey results, 17% of EVSE channel participants owned more than one EV at the end of the Winter 2022/2023 Event Season (Table 10).

Table 9. Residential Charging Pilot Participant Characteristics

Metric	Winter 2021/2022	Summer 2022	Winter 2022/2023
EVSE			
Percent Participant Distribution by Rebate Type			
Standard Charger Rebate	89%	90%	90%
Income-Eligible Charger Rebate	8%	7%	8%
BYOC	3%	3%	2%
Panel Upgrade	NA	NA	<1%
Cross Enrollment			
Enrolled in TOD	18%	32%	42%
Enrolled in PTR	24%	12%	18%
Total EVSE Participants	**581**	**947**	**1,435**
evPulse			
Enrolled in TOD	43%	43%	46%
Enrolled in PTR	28%	16%	20%
Total evPulse Participants	**503**	**460**	**1,282**

Among participants who took the Winter 2022/2023 post-event survey, most own more than one vehicle (82%), nearly three-quarters (72%) own an internal combustion engine (ICE) vehicle in addition to an EV, and approximately one-fifth own more than one EV (19%) (Table 10). According to the tracking data, a very small number of EVSE participants (four during the Summer 2022 season) enrolled more than one charger in the pilot, suggesting that the rest of the participants who had more than one EV used a single charger. evPulse tracking data showed that 7% of participating accounts had more than one Tesla enrolled in the pilot. We found little difference between EVSE and evPulse participants in the ownership of an ICE vehicle or the number of vehicles owned. However, EVSE participants are much more likely to own a PHEV than evPulse participants (29% vs. 4%).[20]

Participants in both channels of the Residential Charging Pilot are overwhelmingly middle- and high-income owners of single-family homes, consistent with expected demographics of EV owners given the relatively high upfront cost of most EVs. Less than 1% of pilot participants rent their home or live in a multifamily or mobile home. Approximately two-thirds had household incomes of more than $150,000 in 2022.

[20] The program tracking data contained information on the primary EV in the household. Customers who owned more than one EV could also provide information on secondary vehicles, but we found that these data were not well-populated when compared to the survey results for the same participants. Therefore, most of our reporting on vehicle ownership comes from the survey data. The program tracking data showed consistency over the event seasons on items related to the primary vehicle, such as the percentage that were BEVs versus PHEVs for the EVSE channel.

Table 10. Residential Charging Pilot Participant Characteristics (Post-Event Survey)

Metric		All	EVSE	evPulse
Vehicles	Have more than one vehicle	82%	82%	84%
	Have more than one EV	19%	17%	21%
	Have a BEV	83%	72%	100%
	Have a PHEV	19%	29%	4%
	Have an ICE vehicle	72%	72%	72%
Home Ownership	Own	99%	99%	99%
	Rent	<1%	<1%	<1%
Home Type	Single-family or townhouse	99%	98%	99%
	Multifamily building	<1%	1%	<1%
	Mobile, manufactured, or other	<1%	1%	<1%
Household Income	Less than $50,000	2%	3%	1%
	At least $50,000 and less than $100,000	11%	12%	11%
	At least $100,000 and less than $150,000	21%	21%	20%
	$150,000 or more	66%	64%	69%
Number of Respondents		944	577	367

The Residential Charging Pilot has been effective at reaching customers in underserved communities. The evaluation team mapped pilot participants to census tracts identified by PGE as containing high proportions of underserved customers as defined by HB2165 and found that approximately half (46%) of participants lived in one or more of the underserved community types (Table 11). Of the underserved community types, participants most frequently lived in communities of color, communities adversely harmed by environmental health hazards, and low-income areas.

Table 11. Proportion of Residential Charging Pilot Participants in Underserved Communities (PGE GIS Analysis)

Underserved Community Criteria	All	EVSE	evPulse
Communities of color	23%	19%	28%
Environmental health hazard area	16%	18%	13%
Low-Income communities	16%	17%	13%
Area with high proportion of renters	10%	11%	9%
Area with high proportion of multifamily	4%	4%	4%
Rural communities	2%	2%	1%
Tribal communities	0%	0%	0%
Any underserved community	46%	46%	47%

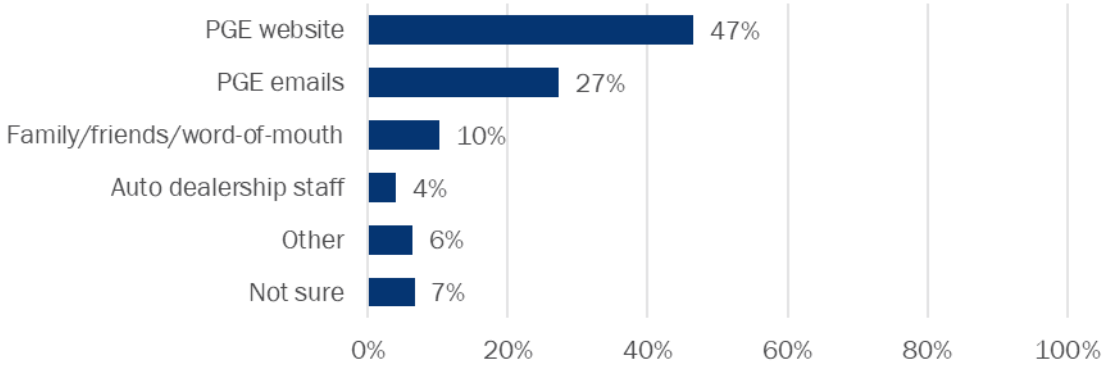
Note: Underserved community criteria are not mutually exclusive.

3.2 PILOT MARKETING AND ENROLLMENT

Since the launch of the Residential Charging Pilot, staff have designed and implemented wide-ranging marketing campaigns aimed at generating awareness of the pilot, sometimes in concert with broader efforts to promote EV adoption. These efforts initially included email campaigns, web advertising, occasional TV spots, ride and drive events, dealership referrals, and educational kiosks. During the past year, marketing primarily focused on email campaigns targeting likely EV owners based on load shape modeling and Oregon Driver and Motor Vehicle (DMV) records. Recent email marketing campaigns also placed emphasis on the availability of both charger rebates and seasonal charging incentives.

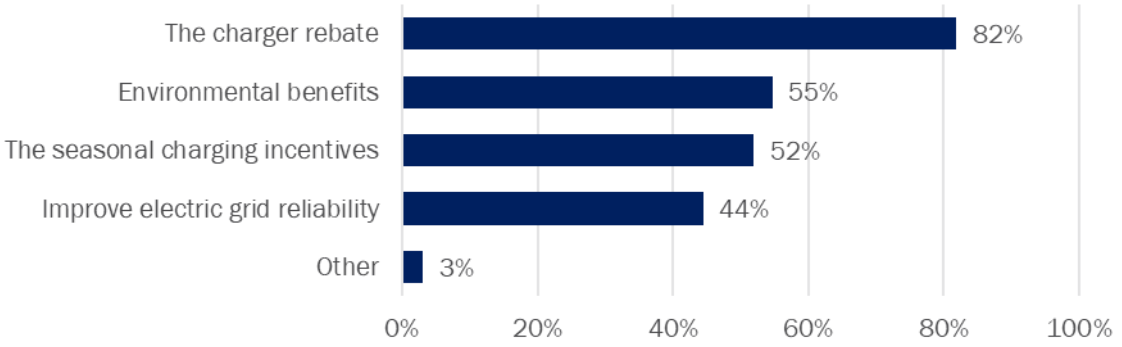
Feedback from surveyed participants suggests that current marketing priorities are well-aligned with customer preferences. When asked how they first learned about the Residential Charging Pilot, most respondents pointed to PGE's website (47%) or email outreach (27%; Figure 1). However, the vast majority suggested that they would prefer to receive information about future PGE EV offerings via email (89%), which is in line with PGE's more recent marketing priorities.[21]

Figure 1. Sources of Residential Charging Pilot Awareness (n=944)



Feedback from pilot participants suggests that future marketing should continue to highlight the various benefits of the pilot, emphasizing charger rebates as a key selling point. Residential Charging Pilot participants pointed to a range of motivations for enrolling in the Residential Charging Pilot, chief among them the charger rebate (82%, Figure 2). Notably, about half of respondents also indicated environmental benefits (55%) and seasonal charging incentives (52%) played a role in their decision to participate, and nearly as many expressed an interest in improving grid reliability (44%).

Figure 2. Motivation to Enroll in Residential Pilot (Multiple Responses Allowed; n=944)

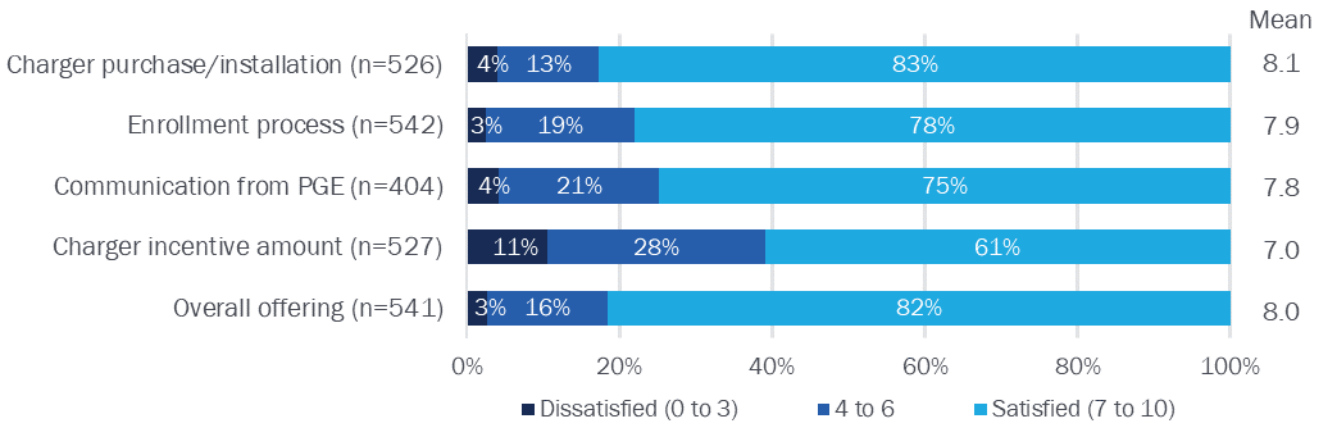


3.3 PILOT PARTICIPATION PROCESS

Surveyed EVSE channel participants expressed relatively high satisfaction with most pilot elements, providing an average rating of 8.0 out of 10 for the offering overall (Figure 3). Respondents reported similar levels of satisfaction with the process of purchasing and installing their new chargers, enrolling in the pilot, and communication received from PGE staff. Incentive amounts associated with charger rebates received slightly lower ratings with some participants wishing a higher portion of the charger purchase and installation was covered.

[21] A smaller portion of respondents also indicated they would like to hear about future PGE EV offerings via online advertising (9%) or via social media (8%). The survey mode (email/web) could conceivably bias these results towards online sources of information, but this is less likely given the high survey response rate.

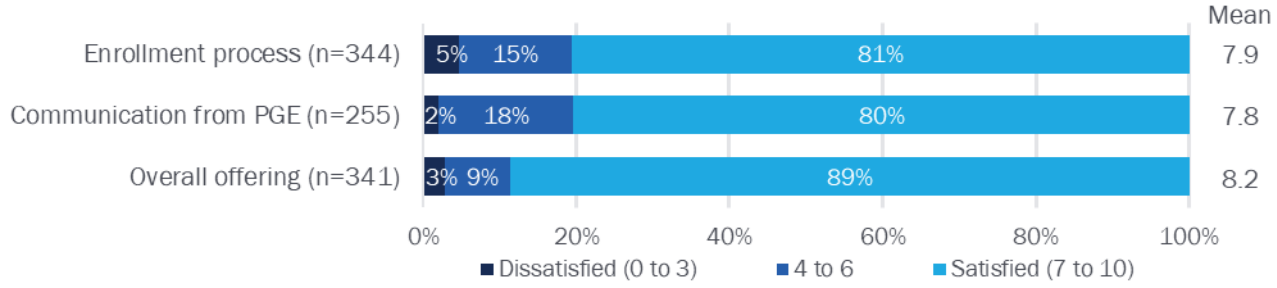
Figure 3. EVSE Channel Participant Satisfaction with Residential Charging Pilot



Note: Varying base sizes reflect exclusion of "not sure" and "not applicable" responses.

Similarly, surveyed evPulse participants reported high satisfaction with applicable aspects of the pilot, giving an average rating of 8.2 out of 10 for the offering overall (Figure 4). The vast majority of respondents expressed satisfaction with both the enrollment process and communication from PGE staff (81% and 80%, respectively). Five percent or fewer of evPulse respondents reported dissatisfaction with key program elements.

Figure 4. evPulse Participant Satisfaction with Residential Charging Pilot



Note: Varying base sizes reflect exclusion of "not sure" and "not applicable" responses.

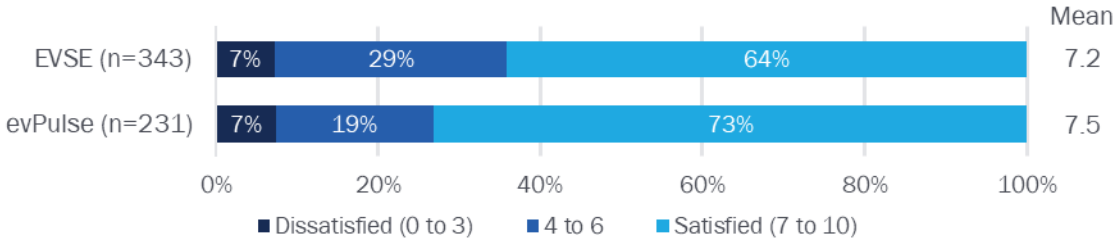
Those respondents who expressed dissatisfaction with key pilot elements typically pointed to the following issues:

- Among EVSE channel participants dissatisfied with charger purchase and installation, 35% pointed to complexity of installation and 19% pointed to difficulty finding a contractor (n=31)
- Those dissatisfied with the enrollment process primarily criticized the amount of paperwork required (64%, n=44)
- Those dissatisfied with program staff communication primarily pointed to non-responses (42%) or slow responses (17%, n=36)
- EVSE channel participants who expressed dissatisfaction with the charger incentive amount unsurprisingly suggested the incentive should be higher (80%, n=66))

Surveyed participants across groups and channels generally found monthly notification emails helpful. Most (82%) respondents recalled receiving monthly notification emails about upcoming events and seasonal charging incentive qualifications, and three-fifths (60%) of those who recalled the emails reported finding the notifications to be helpful. Among those who found the notifications unhelpful, the most common complaints were that emails did not affect their charging behavior (43%) or that the email was unnecessary (25%).

Most surveyed participants recalled receiving the $25 seasonal participation bill credit and expressed satisfaction with the amount provided, though a substantial portion were not able to identify all participation requirements. Nearly two-thirds of surveyed participants reported qualifying for and receiving the $25 bill credit following the Winter 2022/2023 Event Season (63% and 66%, respectively). However, more than one-third of EVSE (36%) and nearly half of evPulse (47%) channel participants were unable to correctly identify the seasonal incentive participation requirements. Among those who did not qualify for a seasonal incentive, just 27% felt that the notification email made clear what they would need to do differently to qualify in future seasons. Still, the majority of participants across both channels reported moderate to high levels of satisfaction with seasonal incentive amounts (Figure 5).

Figure 5. Satisfaction with Seasonal Bill Credit Amounts by Channel

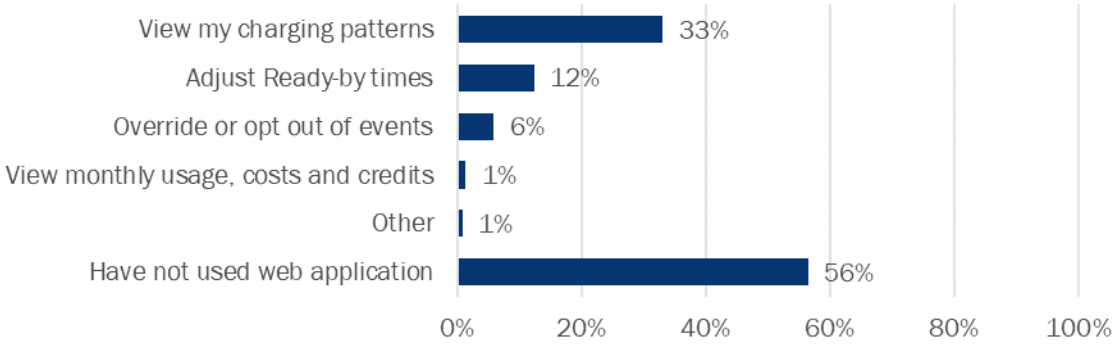


Note: "Not sure" responses are excluded.

Nearly all surveyed participants in the EVSE channel use EV charging mobile apps to control their home charging. The vast majority of EVSE channel participants use their charger's designated mobile app (90%) to control their charging, while a much smaller portion of respondents reported using their vehicle manufacturer's mobile app (3%). Fewer than one in ten respondents indicated they do not use any mobile app to control their vehicle's charging.

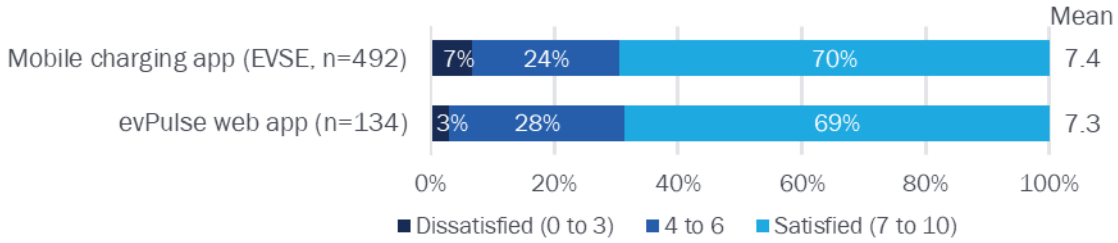
Among surveyed evPulse participants, fewer than half (44%) have made use of the designated evPulse web application. One-third (33%) of respondents reported using the evPulse web application to view their charging patterns, and smaller portions used it to adjust ready-by times (12%) or override DR events (6%; Figure 6). Those who have not used the evPulse web application often did not know it was available (38%), felt it was unnecessary (32%), or preferred another charging app (26%).

Figure 6. evPulse Participant Reasons for Using Designated Web Application (Multiple Responses Allowed; n=356)



Users of EV charging mobile apps and the evPulse web application express similarly high levels of satisfaction with each (Figure 7). EVSE channel participants provided an average satisfaction rating of 7.4 out of 10 for their experience with mobile charging apps, and evPulse web application users reported an average satisfaction rating of 7.3. Few respondents expressed dissatisfaction with either application, but those that did pointed to the mobile app's user interface (56%), glitches that affected charging (20%), or noted that they would prefer a mobile evPulse app to the existing web application (50%).

Figure 7. Satisfaction with Charging Applications by Channel



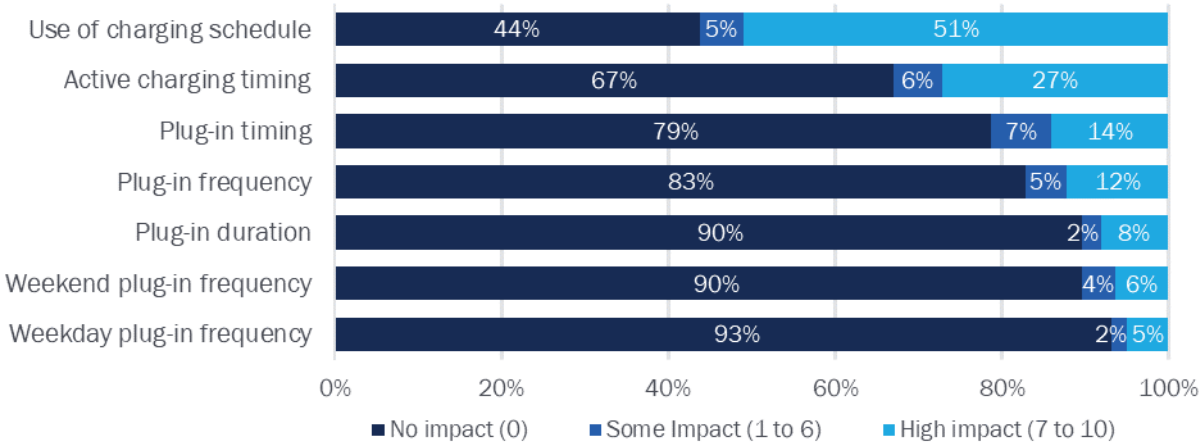
Note: "Not sure" responses are excluded.

3.4 CHARGING BEHAVIOR CHANGES

We asked respondents about the impact of the pilot on several different charging behaviors. To be eligible for the pilot's seasonal bill credit, customers must have their charger connected to the internet at least 50% of the time, charge their vehicles at least 13 times, and participate in at least 3 events during a season. Those with prior EV experience are likely to have a more informed sense of how pilot participation affected their charging tendencies so we framed the questions differently depending on length of EV ownership. For those who drove an EV for at least three months prior to enrolling, we asked whether their behavior changed after enrolling and, if so, the degree to which the pilot impacted that change. For those without prior EV experience, we simply asked them to estimate the degree to which the pilot impacted each charging behavior. We present results separately for those with and without prior EV experience and each channel.

Among EVSE channel participants with prior EV charging experience, the most commonly reported behavior change attributed to the pilot was to begin setting a charging schedule. Among EVSE channel respondents who reported owning an EV for at least three months prior to enrolling in the pilot (39% of all EVSE channel respondents), about half (51%) reported that enrolling in the pilot was highly impactful on their decision to begin setting a charging schedule. (Figure 8). Slightly over one-quarter (27%) indicated it was highly impactful on the timing of their active charging.

Figure 8. EVSE Participant Changes to Typical Charging Behavior After Enrolling (Multiple Responses Allowed; n=221)

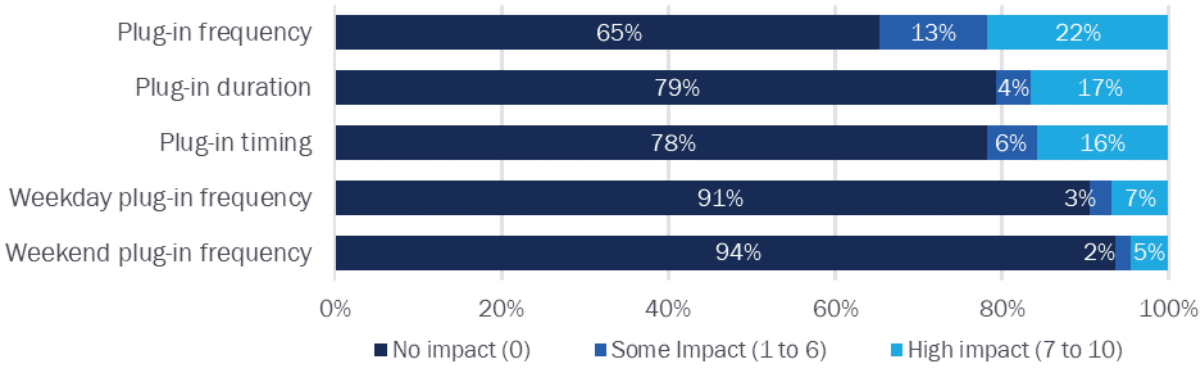


Note: This question was asked only of those who reported owning an EV for at least three months prior to enrolling in the pilot. In addition, "use of charging schedule" was only asked of those who indicated they typically set a charging schedule during the recent event season (n=112).

Most evPulse channel participants who drove an EV prior to enrolling in the pilot reported that the pilot had no impact on their charging behaviors. Among those who did report an impact on charging behaviors, the most often affected behavior was plug-in frequency. Among evPulse channel participants who reported owning an EV for at least three months prior to enrolling in the pilot (75%), approximately one-fifth (22%) reported that enrolling in the pilot was highly

impactful on how often they plugged in their vehicle, while smaller portions of respondents reported high impacts on when they plugged in (17%) or for how long (16%; Figure 9).

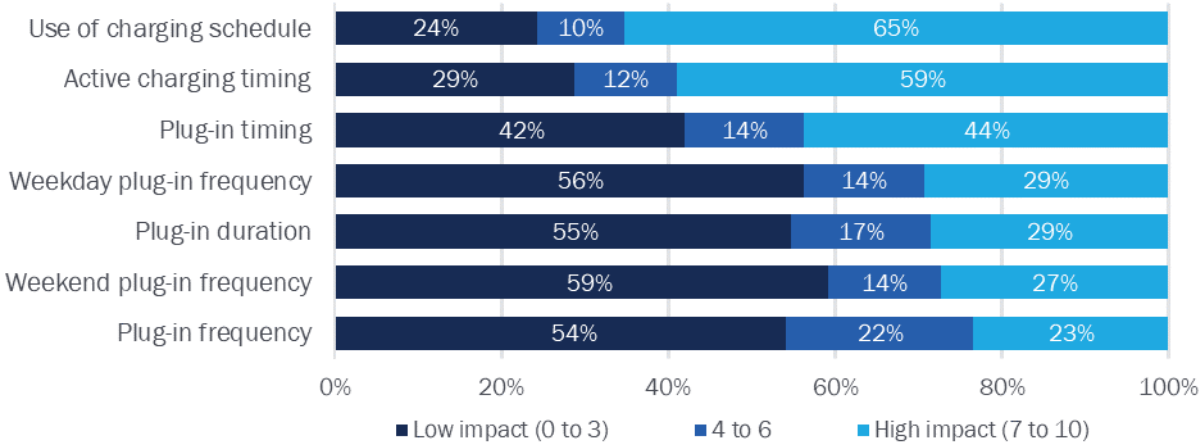
Figure 9. evPulse Participant Changes to Typical Charging Behavior After Enrolling (Multiple Responses Allowed; n=266)



Note: This question was asked only of those who reported owning an EV for at least three months prior to enrolling in the pilot.

Among EVSE channel participants without prior EV charging experience, more reported that the pilot impacted their setting of a charging schedule and the timing of when they charged than other behaviors. For those who did not previously have an EV and established charging habits prior to enrolling in the pilot, we asked respondents to rate the pilot's impact on their charging behaviors. Approximately two-thirds (65%) of EVSE respondents indicated that the pilot was highly impactful on their decision to set a charging schedule (Figure 10).[22] Nearly as many EVSE participants reported the pilot was highly impactful on the timing of their charging (59%), while slightly less than half reported it was highly impactful on when they plugged in their EV (44%).

Figure 10. EVSE Participants' Perceived Impact of Pilot on Home Charging Behavior (n=334)



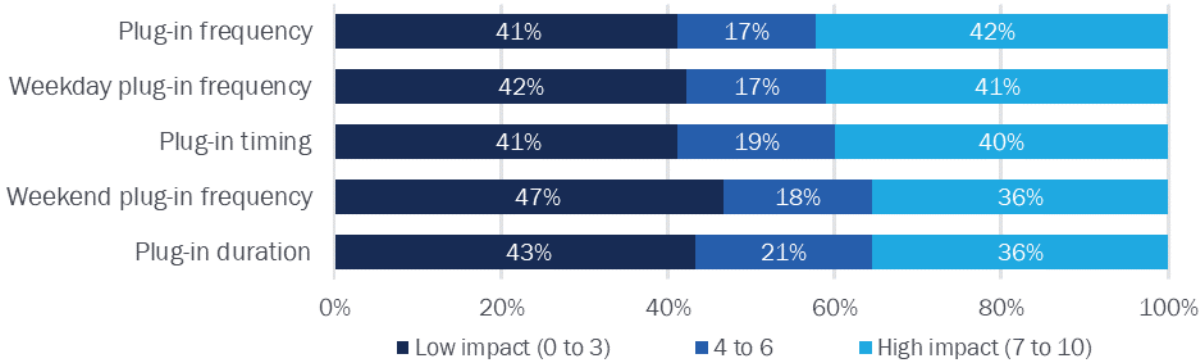
Note: This question was asked only of those who reported owning an EV for less than three months prior to enrolling in the pilot. In addition, "use of charging schedule" was only asked of those who indicated they typically set a charging schedule during the recent event season (n=193).

evPulse channel participants without prior EV experience were split on the impact of the pilot on their charging frequency and timing. Among surveyed evPulse participants who did not drive an EV prior to enrolling in the pilot, approximately two-fifths indicated that the pilot was highly impactful on the frequency with which they plug-in their vehicle (42%), the frequency with which they plug-in during the week (41%), and the timing of when they plug-in (40%;

[22] This was only asked of those who actively set a charging schedule during the Winter 2022/2023 Event Season.

Figure 11). However, similar percentages reported that the pilot had little impact on these behaviors as well as weekend charging frequency and plug-in duration.

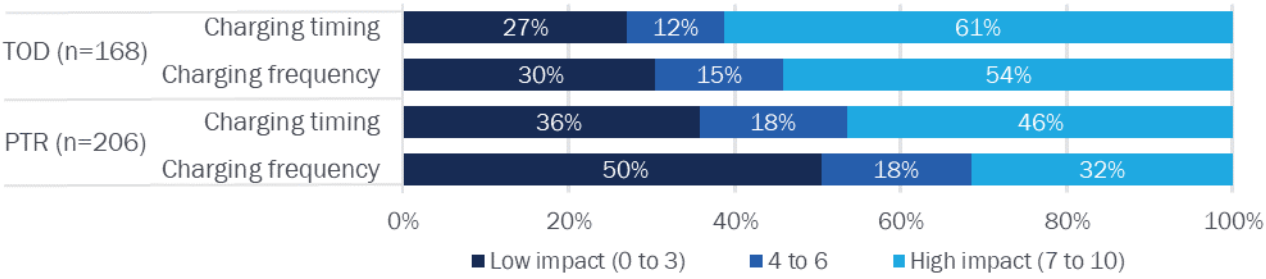
Figure 11. evPulse Participants' Perceived Impact of Pilot on Home Charging Behavior (n=90)



Note: This question was asked only of those who reported owning an EV for less than three months prior to enrolling in the pilot.

Participants enrolled in PGE's TOD rate and PTR offerings acknowledged the influence of those offerings on their charging behavior prior to enrolling in the Residential Charging Pilot. We asked Residential Charging Pilot participants who were also enrolled in PGE's TOD or PTR offerings to rate the degree to which those offerings affected their EV charging behavior prior to enrolling in the Residential Charging Pilot. More than half of those enrolled in PGE's TOD offering suggested it was highly impactful in the timing (61%) and frequency (54%) of their EV charging (Figure 12). Those enrolled in PTR reported somewhat lower impact, with about half (46%) indicating their enrollment in PTR was highly impactful on the timing of their EV charging and about one-third (32%) indicating it highly impacted the frequency.

Figure 12. Impact of TOD and PTR Offerings Prior to Pilot Enrollment on Charging Timing and Frequency



TOD participants were also significantly more likely to typically set a charging schedule during the Winter 2022/2023 Event Season than non-TOD participants (78% versus 51%). However, both TOD and non-TOD participants reported similar levels of Residential Charging Pilot influence on their tendency to set a charging schedule.

3.5 RESIDENTIAL CHARGING PATTERN ANALYSIS

As part of the charging pattern analysis, we explored overall charging load, charging load patterns by day of the week as well as hours of the day under managed and unmanaged scenarios. We also explored differences in charging patterns by participant subgroups of interest, namely by EV type (i.e., BEV vs. PHEV) and TOD rate plan enrollment status. While our analysis reflects the current state of EV charging and driving, it is important to keep in mind the following results from the participant survey:

- While 72% of participating households also own an ICE vehicle, a majority of participants (86%) report using their EV for at least half of weekly driving and another 39% rely on their EV for 90% of typical weekly driving. As EVs increase in presence and replace ICE vehicles as the second vehicle in the household, EV charging needs and patterns may change.
- The charging pattern analysis only includes at-home charging of the participating EVs and does not include charging load from other charging sources such as workplace and public charging locations. According to the participant survey, about two-thirds (64%) of participants charge their EVs exclusively at home while just over one-fifth (21%) use public charging stations and one-tenth (10%) use workplace charging. The evPulse charging data contained data on charging at home and away from home. Our analysis revealed that between 18% and 24% of charging load consumption occurred away from home, depending on the event season. Charging away from home is not managed as part of the Residential Charging Pilot. As EV adoption grows and expands to more customers who are unable to charge at home, charging at public and other locations will be important to monitor.

3.5.1 OVERALL CHARGING LOAD

An average Tesla participating in the evPulse channel uses considerably more electricity than the average participating EVSE vehicle. Depending on the event season, an average vehicle participating in the EVSE channel uses between 6.35 kWh and 7.25 kWh per day, which over the course of an average week amounts to between 44.45 kWh and 50.72 kWh in energy consumed (Table 12). Depending on the season, the average evPulse participant requires between 8.71 kWh and 9.34 kWh to charge per day and 60.97 kWh and 65.36 kW per week. The difference by channel is due, in part, to the presence of PHEVs in the EVSE channel. Between 27% and 32% of the EVSE channel participants (depending on the event season) were PHEVs, which had lower average charging consumption than the BEVs (between 8% and 20% lower). Still, the average BEV enrolled in the EVSE channel had lower consumption than the average Tesla enrolled in the evPulse channel (between 18% and 25% lower depending on the season). Should the vehicle mix in the Residential Charging Pilot change toward a higher proportion of BEVs, the load shifting impacts may shift as well.

The amount of energy needed to charge participating EVs varies slightly across seasons for both the EVSE and evPulse vehicles. Consumption was lower during the Summer 2022 Event Season than either of the winter seasons, likely due to warmer weather and thus higher battery efficiency from not needing to heat the vehicle. But we also found differences in consumption between the two winter event seasons, with greater consumption during the Winter 2022/2023 Event Season than the 2021/2022 Winter Event Season. Because the participant mix is different from season to season, further exploration would be needed to understand the exact causes of seasonal differences in energy consumption. Such exploration could include isolating participants enrolled in the Residential Charging Pilot over the course of all three seasons and comparing their charging load across the seasons. Understanding the causes of seasonal and annual differences in charging will allow PGE to better plan EV charging load moving forward.

Table 12. Average Daily and Weekly Consumption per Vehicle/Charger per EV Type and Season

Group/Season	Number of Vehicles/ Chargers	Average Consumption per Vehicle/Charger per Day (kWh)	Average Consumption per Vehicle/Charger per Week (kWh)
Winter 2021/2022			
EVSE	548	6.73	47.11
BEV	372	7.15	50.05
PHEV	175	5.87	41.06
evPulse	491	8.76	61.32
Summer 2022			
EVSE	924	6.35	44.45
BEV	620	6.51	45.55
PHEV	264	5.94	41.61
evPulse	475	8.71	60.97
Winter 2022/2023			
EVSE	1,267	7.25	50.72
BEV	835	7.57	53.02
PHEV	361	6.30	44.07
evPulse	1,248	9.34	65.36

Note: Excludes evPulse charging away from home. PTR event days are excluded from the analysis.

Participants enrolled in the TOD pricing plan have higher home charging load than non-TOD participants. For both the EVSE and evPulse channels and across all three seasons, TOD enrolled participants used more electricity to charge than non-TOD participants (between 6% and 17% more depending on channel and season) (Table 13). Customers with greater at home charging needs may recognize the savings that participation in TOD would bring and are more likely to sign up for the rate.

Table 13. Average Daily Consumption per Vehicle/Charger by TOD Pricing Plan Enrollment Status

Group/Season	Non-TOD		TOD	
	Number of Vehicles/ Chargers	Average Consumption per Vehicle/Charger per Day (kWh)	Number of Vehicles/ Chargers	Average Consumption per Vehicle/Charger per Day (kWh)
Winter 2021/2022				
EVSE	456	6.64	92	7.18
evPulse	281	8.20	210	9.56
Summer 2022				
EVSE	617	6.19	307	6.75
evPulse	264	8.23	211	9.30
Winter 2022/2023				
EVSE	746	6.91	521	7.77
evPulse	669	9.08	579	9.64

Note: Excludes evPulse charging away from home. PTR event days are excluded from the analysis.

3.5.2 UNMANAGED CHARGING PATTERNS

The Residential Charging Pilot assigned a portion of EVSE channel participants to a control group (Group A), which allowed us to explore EV charging patterns in an unmanaged environment. Exploration of unmanaged charging patterns allows us to better understand the amount of charging load available for reduction during event hours as well as the implications of shifting load to non-event hours, which can inadvertently create additional peaks. The presence of the TOD rate also has the potential to alter participant load given price signals.

Overall, customers conduct between 69% and 71% of their charging on weekdays, depending on the event season. Customers conduct their remaining charging on the weekend, nearly evenly between Saturdays and Sundays. Unmanaged charging varies over the course of the week, with Mondays emerging as the day with the least charging occurring (Figure 13). Charging over the course of other weekdays varies somewhat, but with no observable pattern. Charging patterns are consistent season-over-season by day of the week. Such consistency of the overall charging patterns by the day of the week suggests that the impacts from the managed charging interventions could be consistent as well across weekdays. That said, with Monday having slightly lower charging volume, PGE should be mindful of the possible load impact differences on that day.

Figure 13. Control Group (Group A) Charging Patterns by Day of the Week and Event Season

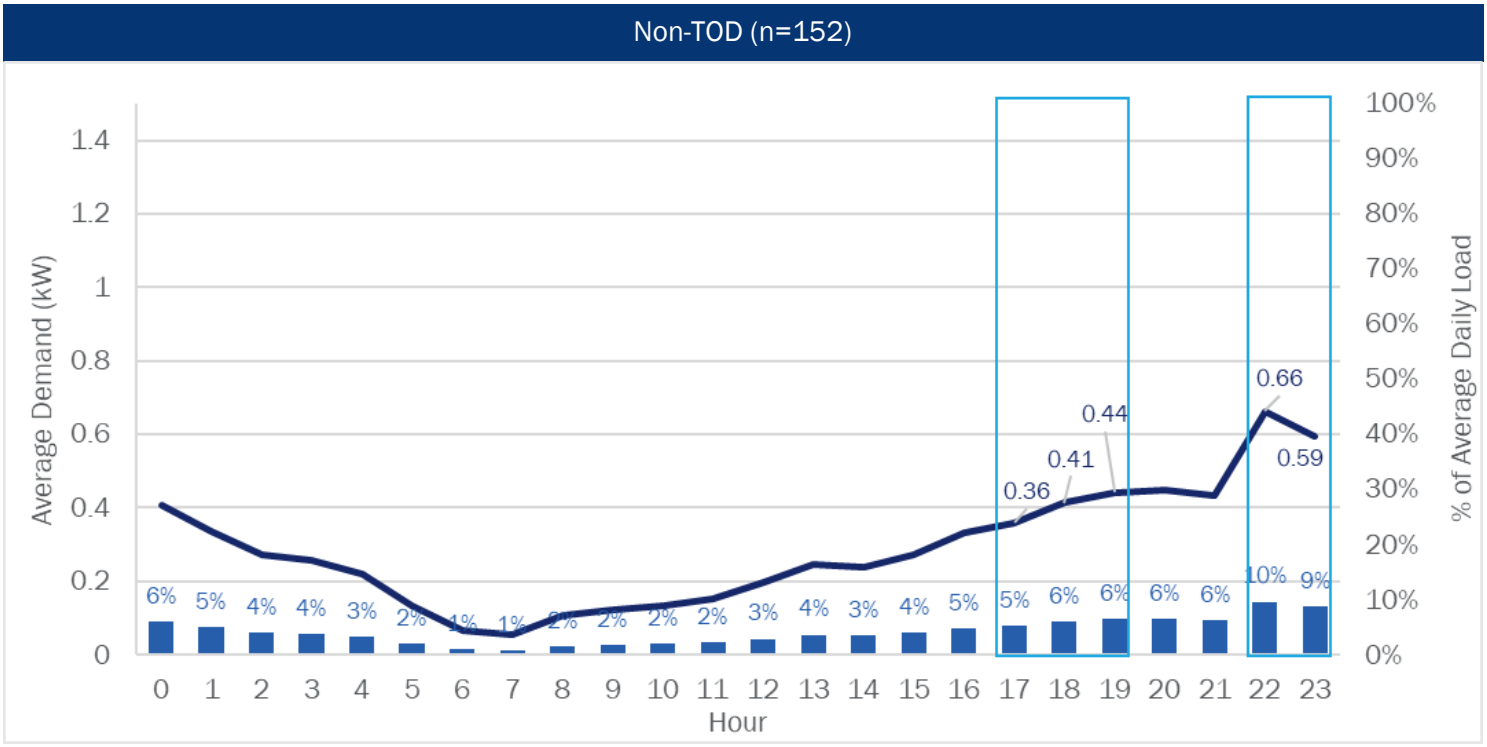
Figure 14, Figure 15, and Figure 16 provide average hourly weekday load shapes for Group A EVSE channel participants for each of the three seasons. We present load shapes for TOD and non-TOD enrollees separately. The TOD population sizes in the Winter 2021/2022 and Summer 2022 Event Seasons are small and the load shapes, as such, should be treated with caution. The figures highlight the two event windows used as part of the Residential Charging Pilot.

Across all seasons, less than one-fifth of all unmanaged non-TOD charging load occurs between the peak hours of 5:00 p.m.–8:00 p.m., the Group B event window. Hourly load during those hours varies from 0.30 kW to 0.47 kW depending on the hour and Event Season. Hourly load is the lowest at 5:00 p.m. and increases steadily during the early evening hours. For all but one hour during the three event seasons, there was not enough unmanaged charging load from 5:00 p.m. to 8:00 p.m. to meet the Residential Charging Pilot's impact planning assumption of 0.45 kW per vehicle/charger.

The TOD rate is effective at shifting load during peak hours. The hourly charging load of Group A TOD enrollees does not exceed 0.19 kW during the Group B event window of 5:00 p.m.–8:00 p.m., and is considerably lower than that of non-TOD participants. Because of the overlap with the TOD On-peak period, the pilot assigned TOD enrollees in the EVSE channel to Group C, which stops EV charging from 10:00 p.m.–11:59 p.m.

The Group C event window of 10:00 p.m.–11:59 p.m. has more load shift potential than the Group B window for both Group A non-TOD and TOD enrollees. Non-TOD charging load gradually increases throughout the evening before more sharply increasing at 10:00 p.m. The average hourly charging load during the Group C window ranges from 0.59 kW to 0.67 kW, depending on the season. It is likely that customers have programmed their chargers to begin charging later at night, but it is unclear why since these customers are not enrolled in TOD. Unsurprisingly, TOD customers show an even greater increase in their charging load beginning at 9:00 p.m., when peak rates end. The charging load of TOD enrollees during the Group C event window ranges from 1.04 kW to 1.4 kW, depending on the hour and the season.

Figure 14. Average Hourly Demand of Control Group (Group A) in Winter 2021/2022 Event Season



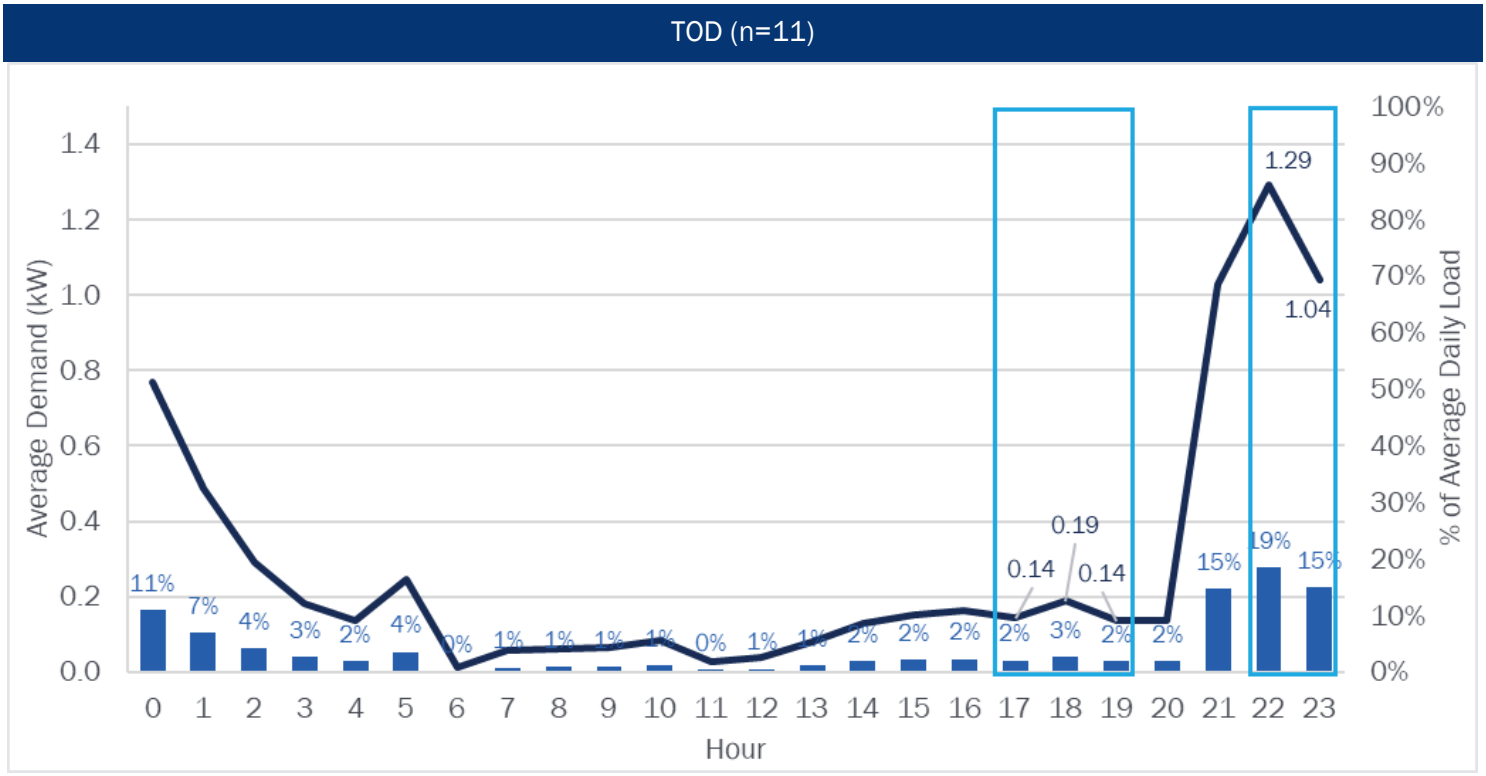


Figure 15. Average Hourly Demand of Control Group (Group A) in Summer 2022 Event Season

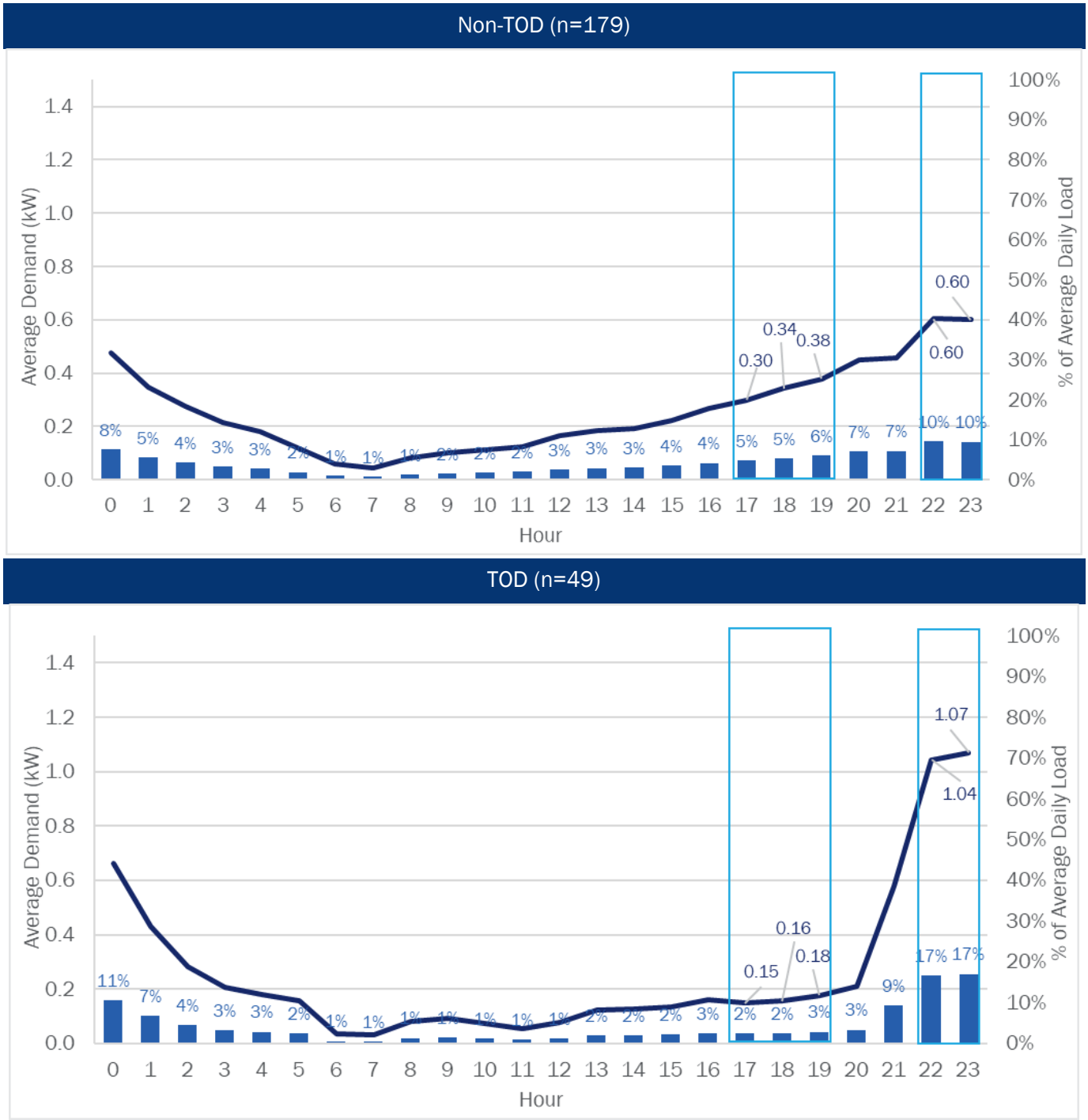
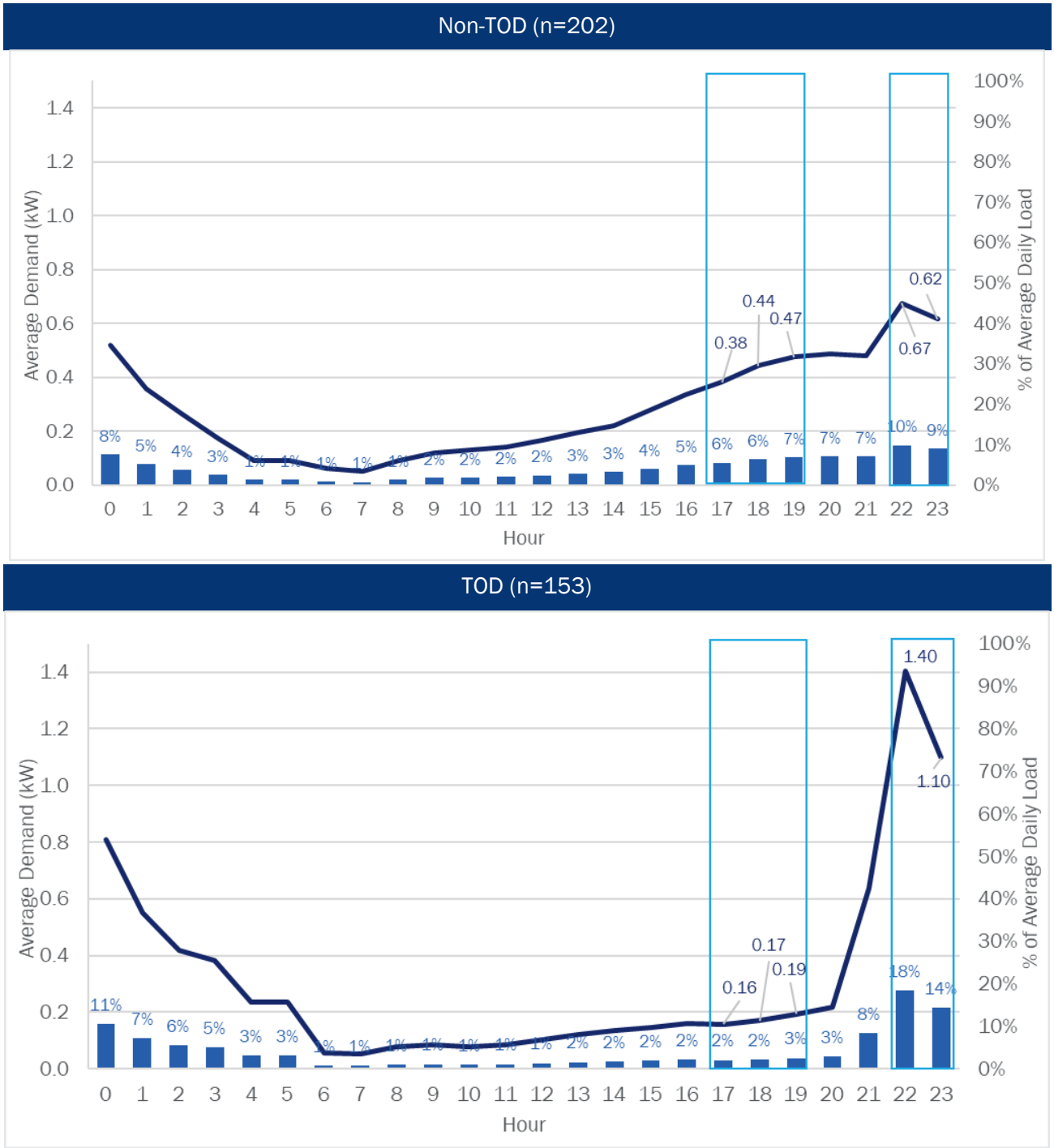


Figure 16. Average Hourly Demand of Control Group (Group A) in Winter 2022/2023 Event Season



The TOD rate shifts charging to late at night and away from peak hours but also has a slight impact on charging during the rest of the day as well. Table 14 provides a summary of the 24-hour charging load during the two pilot event windows (5:00 p.m.–8:00 p.m. and 10:00 p.m.–11:59 p.m.) as well as during the remaining hours of the event day. Both the share of charging as well as average hourly load among TOD participants is half that of non-TOD participants during the TOD peak period (5:00 p.m.–8:00 p.m.),[23] and three-quarters to nearly twice as high between 10:00 p.m. and 11:59 p.m. During all other weekday hours, charging load among non-TOD participants is 2%–6% higher compared to TOD participants.

[23] TOD peak period is 5:00 p.m.–9:00 p.m.

Table 14. Average Percent of Load Consumed by Time Period on Event Days

Season	Time Period	Control Group (Group A) % of Load		Control Group (Group A) Average Hourly (kW)	
		TOD	Non-TOD	TOD	Non-TOD
Winter 2021/2022	*Charger/Vehicle Count*	*11*	*152*	*11*	*152*
	5:00 p.m. – 8:00 p.m.	7%	18%	0.16	0.41
	10:00 p.m. – 11:59 p.m.	34%	18%	1.17	0.63
	All Other Hours	60%	64%	0.22	0.23
Summer 2022	*Charger/Vehicle Count*	*49*	*179*	*49*	*179*
	5:00 p.m. – 8:00 p.m.	8%	16%	0.16	0.34
	10:00 p.m. – 11:59 p.m.	34%	19%	1.06	0.60
	All Other Hours	59%	65%	0.19	0.21
Winter 2022/2023	*Charger/Vehicle Count*	*153*	*202*	*153*	*202*
	5:00 p.m. – 8:00 p.m.	7%	19%	0.17	0.43
	10:00 p.m. – 11:59 p.m.	33%	19%	1.25	0.65
	All Other Hours	60%	62%	0.24	0.22

3.5.3 MANAGED CHARGING PATTERNS

Residential Charging Pilot participant charging patterns changed considerably under managed charging conditions implemented through the pilot. The extent of the change varied depending on the combination of the hours during which participant charging was managed and whether the participant was enrolled in the TOD rate. Figure 17 through Figure 25 show managed charging load shapes for each of the managed charging groups by season and by the presence of the TOD pricing plan. For ease of comparison, we overlaid the managed charging patterns in the figures below with the unmanaged charging patterns from the control group (Group A; light blue dotted line in the figures). Because each group had different managed charging hours, we highlight the relevant event windows in the figures as well.

GROUP B EVSE MANAGED CHARGING PATTERNS

Figure 17, Figure 18, and Figure 19 display the managed charging patterns of non-TOD EVSE channel participants who were assigned to Group B for the three event seasons. Due to the very small number of TOD participants in Group B, we do not present TOD participant load shapes separately.

During the Group B event window (5:00 p.m.–8:00 p.m.), EV charging load was between 0.05 kW–0.11 kW, depending on the hour and event season. At any given hour during the event window, charging load did not exceed 2% of the average weekday charging load, and across all hours the load did not exceed 5% of the average weekday charging load. Relative to Group A non-TOD, participants conducted more of their charging in the four hours following the end of the period (8:00 p.m.– 11:59 p.m.) with 8:00 p.m. seeing the highest increase in load. These charging patterns are generally consistent across the three event seasons.

Figure 17. Average Hourly Demand of Group B EVSE Non-TOD Participants (N=154) – Winter 2021/2022

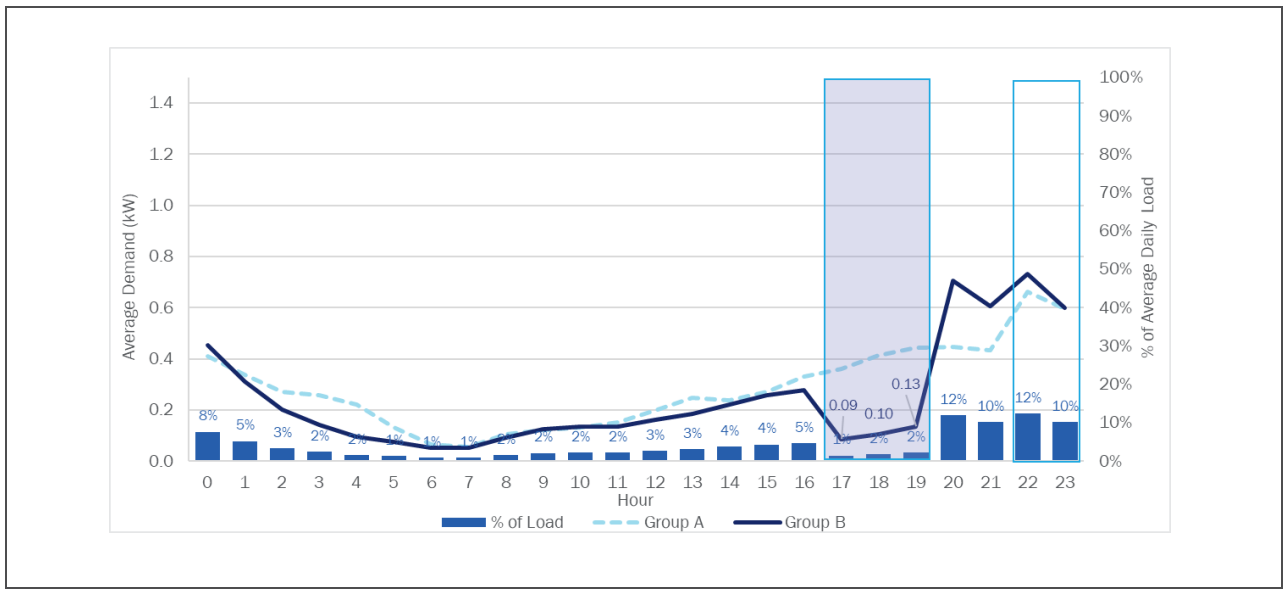


Figure 18. Average Hourly Demand of Group B EVSE Non-TOD Participants (N=229) – Summer 2022

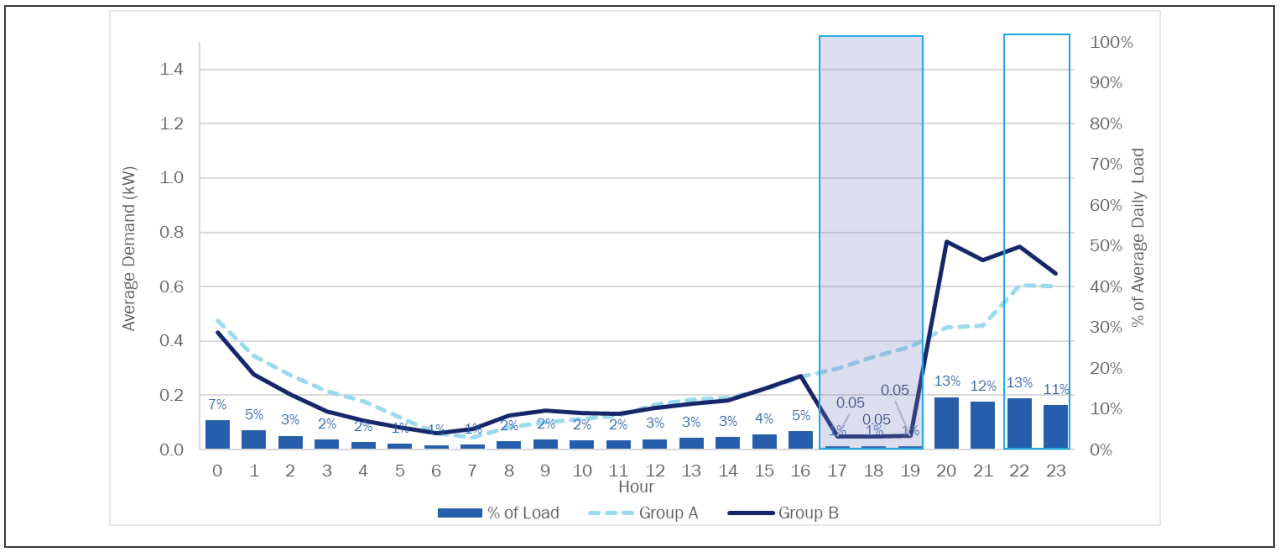
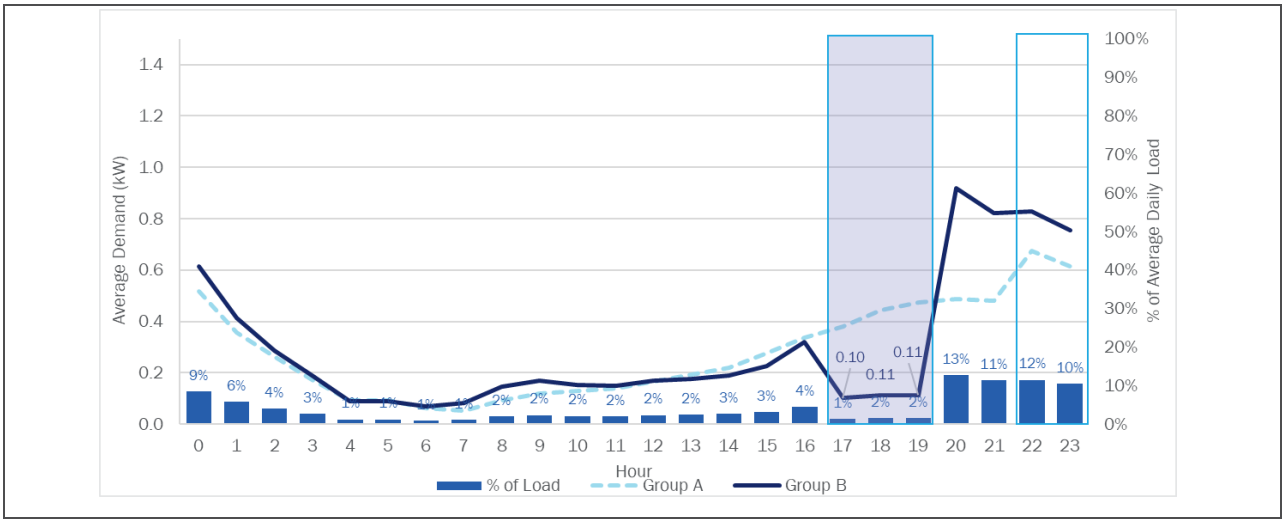


Figure 19. Average Hourly Demand of Group B EVSE Non-TOD Participants (N=303) – Winter 2022/2023



GROUP C MANAGED CHARGING PATTERNS

Figure 20, Figure 21, and Figure 22 display the managed charging patterns of TOD and non-TOD EVSE channel participants who were assigned to Group C for the three event seasons.

Managed charging patterns during the Group C event window of 10:00 p.m.–11:59 p.m. were different for non-TOD and TOD enrollees. The absolute kW load during the event hours was considerably higher for Group C TOD participants compared to Group C non-TOD participants. However, relative to Group A TOD, Group C TOD participants appear to have considerably more load reduction than Group C non-TOD participants have relative to Group A non-TOD. For Group C non-TOD participants, charging load decreased from 0.08 kW to 0.18 kW depending on the hour and event season. At any given hour in that period, the load did not exceed 2% of the average weekday charging load, and across all hours the load did not exceed 6% of the average weekday charging load.

Group C TOD participant load ranged from 0.18 kW to 0.40 kW depending on the event hour and the season. The load represented between 4% and 7% of the average weekday charging load at any given event hour and between 6% and 14% of the average weekday charging load across the two event hours. Relative to Group A, both non-TOD and TOD Group C participants conducted more of their charging in the overnight hours. Due to the off-peak period starting at 9:00 p.m., there is a spike in charging during that hour among TOD participants.

Figure 20. Average Hourly Demand of Group C EVSE in Winter 2021/2022

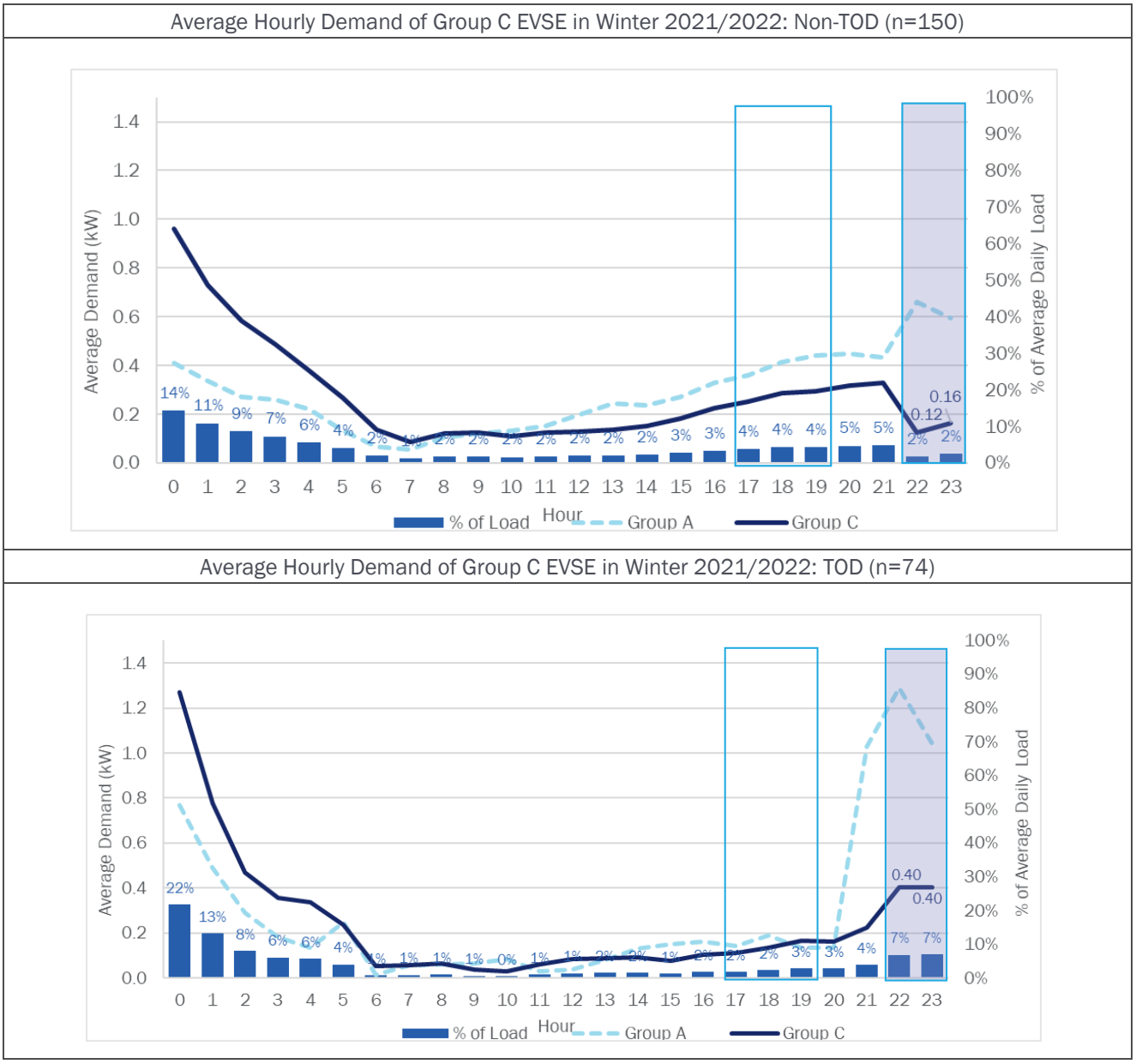
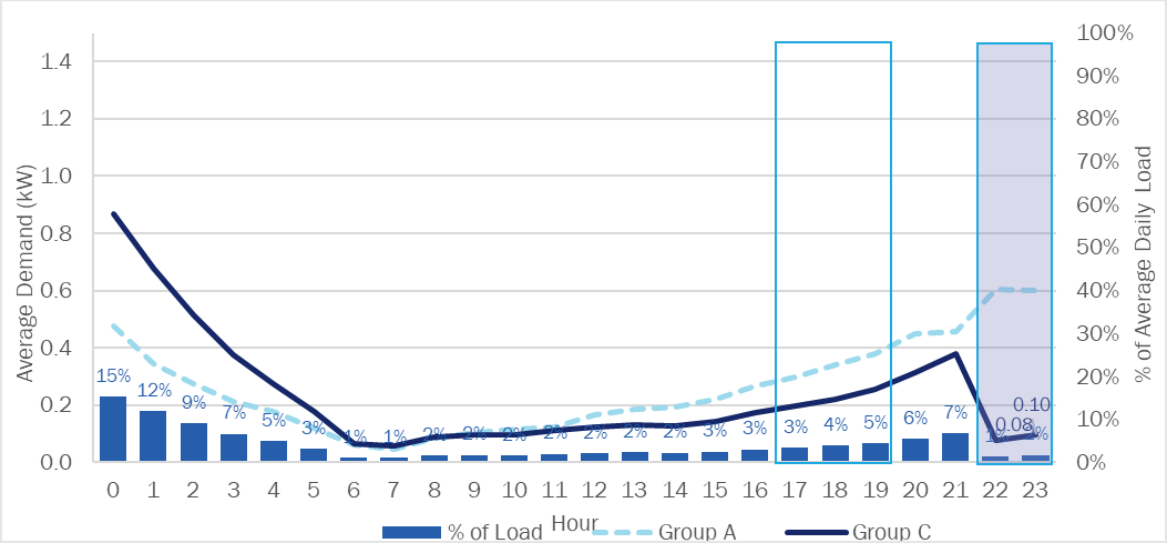


Figure 21. Average Hourly Demand of Group C EVSE in Summer 2022

Average Hourly Demand of Group C EVSE in Summer 2022: Non-TOD (n=209)



Average Hourly Demand of Group C EVSE in Summer 2022: TOD (n=243)

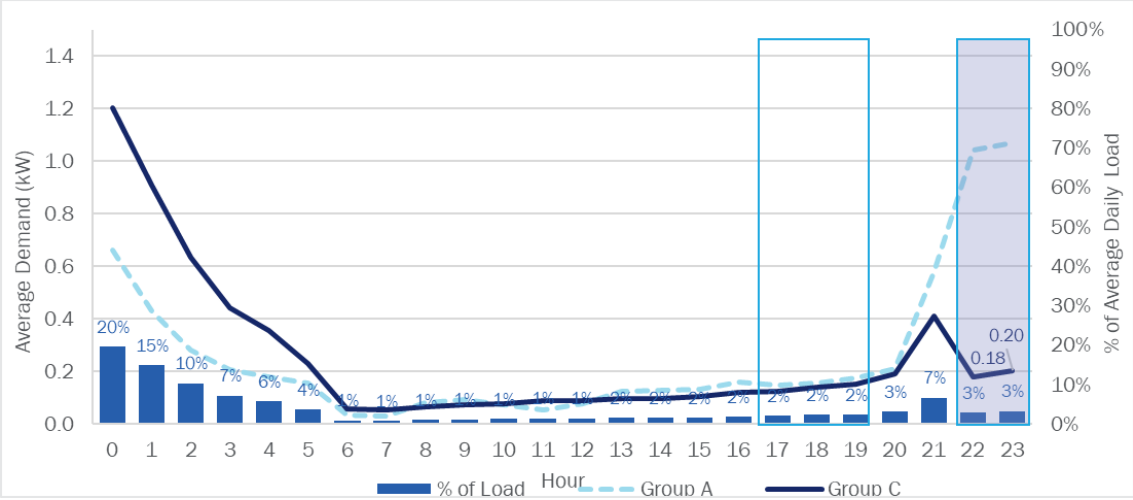
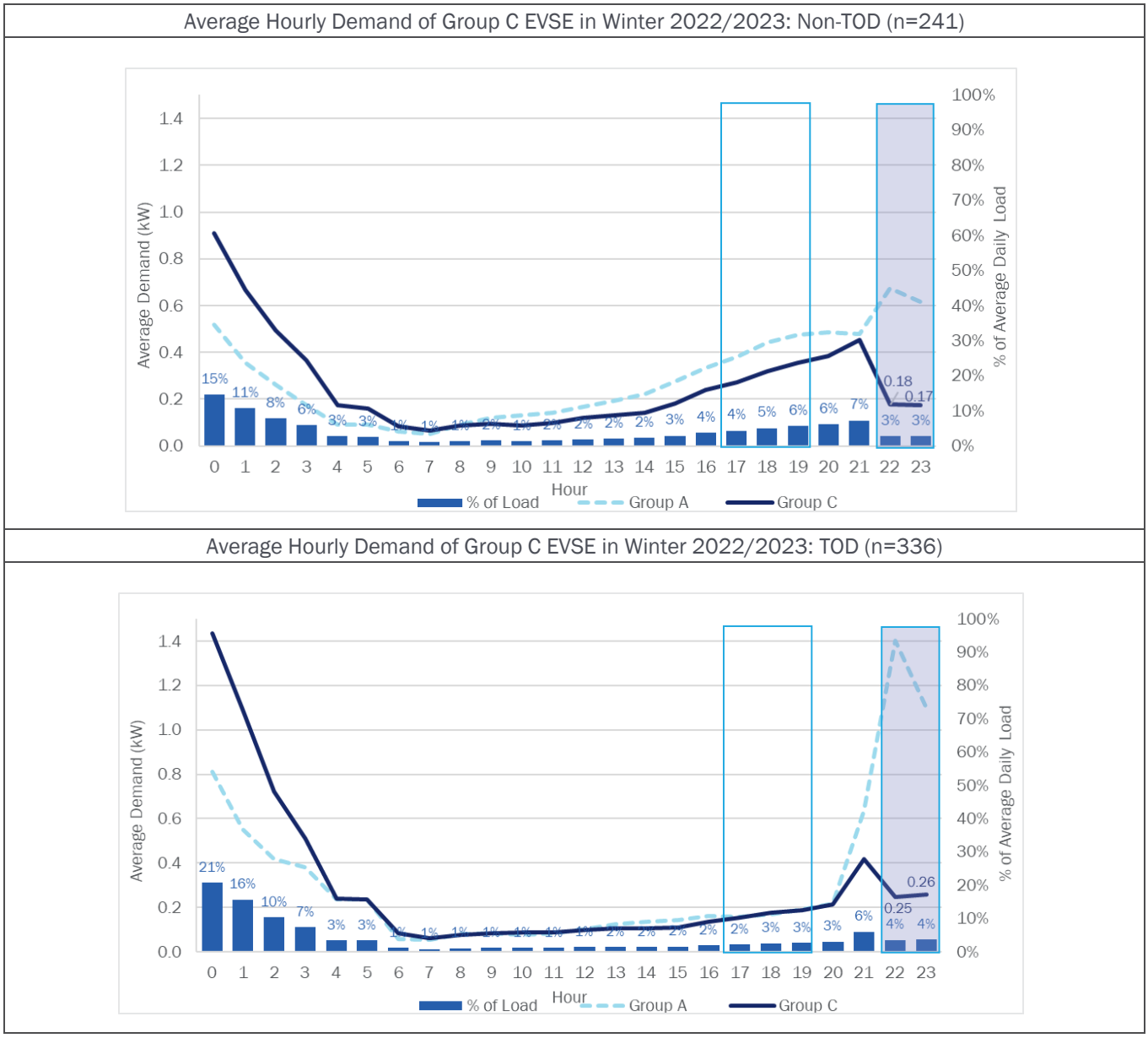


Figure 22. Average Hourly Demand of Group C EVSE in Winter 2022/2023



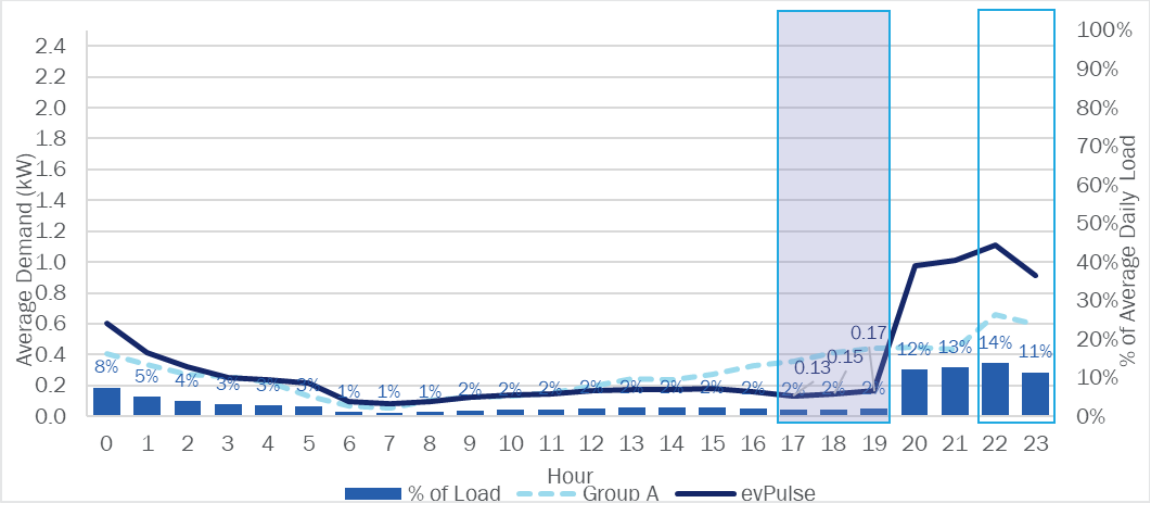
EVPULSE MANAGED CHARGING PATTERNS

Figure 23, Figure 24, and Figure 25 display the managed charging patterns of the evPulse TOD and non-TOD participants for the three event seasons. While we include the control group (Group A) charging profile in the figures, caution should be used when comparing the two profiles as the evPulse participant population is different both in terms of vehicle types as well as overall charging load.

Both TOD and non-TOD evPulse Group B participants have similar load charging patterns during the Group B event window (5:00 p.m.–8:00 p.m.) with hourly load increasing over the course of the event. During the Summer 2022 and Winter 2022/2023 Event Seasons, evPulse Group B hourly load ranged from 0.07 kW to 0.1 kW, depending on the hour. Average hourly charging load during event hours was higher during the winter 2021/2022 Event Season, ranging from 0.13 kW to 0.18 kW. Relative to Group A, Group B evPulse participants, both TOD and non-TOD, conducted more of their charging load in the hours following the end of the period. Because the TOD peak period runs until 9:00 p.m., the increase in charging load for TOD participants begins an hour later than non-TOD participants.

Figure 23. Average Hourly Demand of evPulse (Group B) in Winter 2021/2022

Average Hourly Demand of evPulse (Group B) in Winter 2021/2022: Non-TOD (n=281)



Average Hourly Demand of evPulse (Group B) in Winter 2021/2022: TOD (n=210)

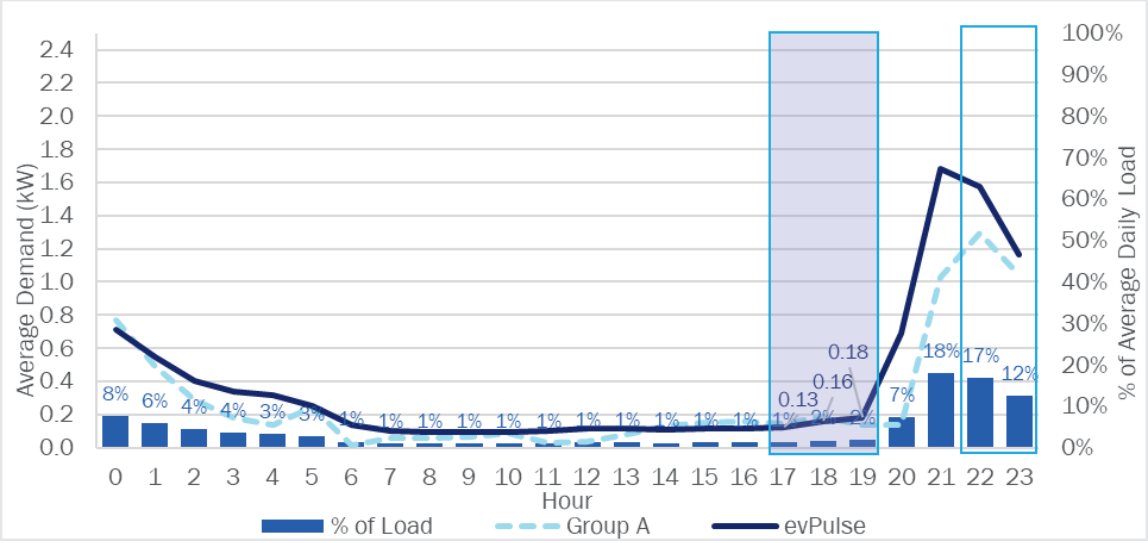
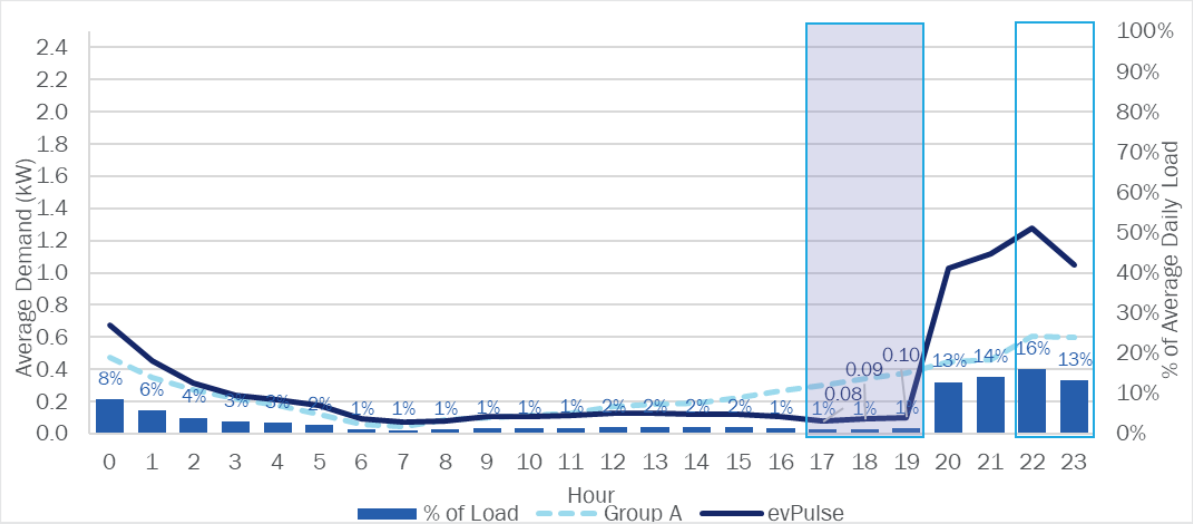


Figure 24. Average Hourly Demand of evPulse (Group B) in Summer 2022

Average Hourly Demand of evPulse (Group B) in Summer 2022: Non-TOD (n=264)



Average Hourly Demand of evPulse (Group B) in Summer 2022: TOD (n=211)

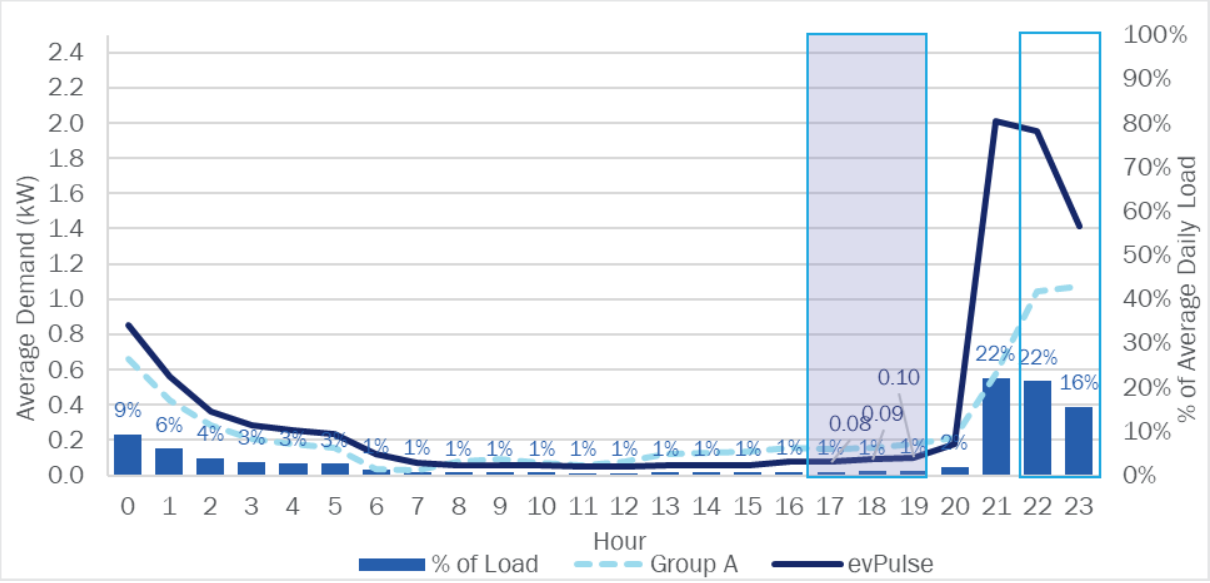
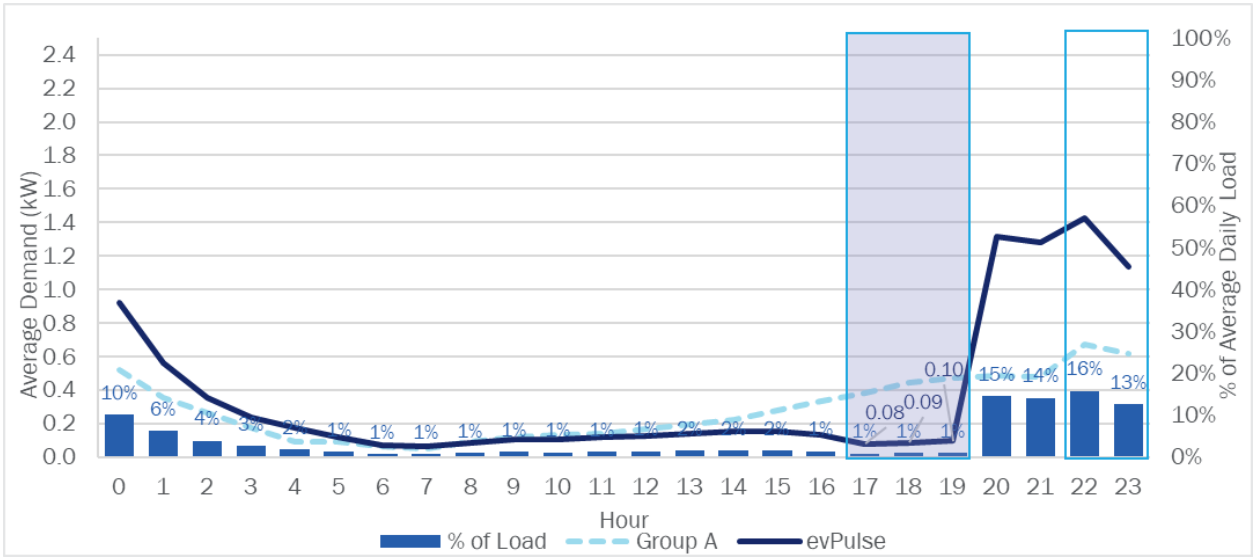
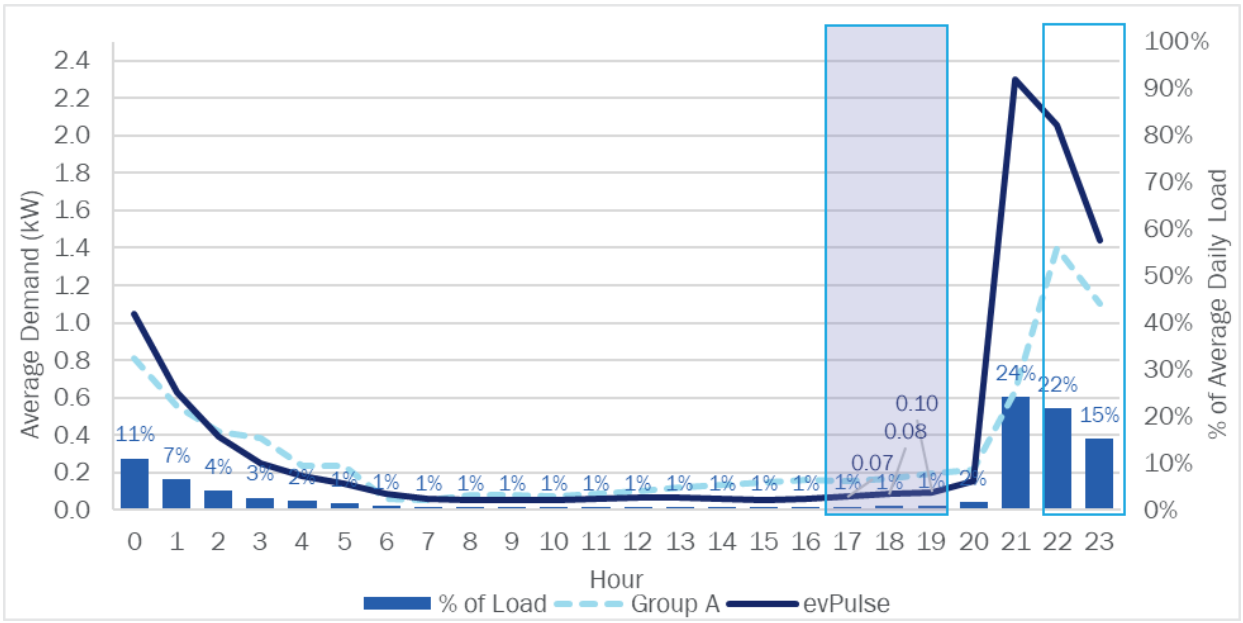


Figure 25. Average Hourly Demand of evPulse (Group B) in Winter 2022/2023

Average Hourly Demand of evPulse (Group B) in Winter 2022/2023: Non-TOD (n=699)



Average Hourly Demand of evPulse (Group B) in Winter 2022/2023: TOD (n=579)



ALL TREATMENT GROUPS MANAGED CHARGING PATTERNS

Table 15 and Table 16 provide a summary of the 24-hour charging load during the two pilot event windows (5:00 p.m. to 8:00 p.m. and 10:00 p.m. to 11:59pm) as well as during the remaining hours of the event day. The tables allow comparison of the three treatment groups and the control group, differentiated by TOD enrollment status where participant population sizes allow. The specific event hours of each treatment group are highlighted in blue.

A comparison of the relative charging load during event hours between the treatment and control groups shows a clear shift in the charging load across all treatment groups. However, charging during event hours did not drop to zero, suggesting some customers opted out or overrode managed charging curtailment (Table 15).

Table 15. Average Percent of Load Consumed by Time Period on Event Days

Season	Time period	TOD			Non-TOD			
		Group A (Control)	Group B (evPulse)	Group C	Group A (Control)	Group B (EVSE)	Group B (evPulse)	Group C
Winter 2021/2022	*Charger/Vehicle Counts*	*11*	*210*	*74*	*152*	*154*	*281*	*150*
	5:00 p.m.–8:00 p.m.	7%	*5%*	7%	18%	5%	6%	12%
	10:00 p.m.–11:59 p.m.	34%	*29%*	14%	18%	22%	25%	4%
	All Other Hours	60%	*66%*	79%	64%	72%	69%	83%
Summer 2022	*Charger/Vehicle Counts*	*49*	*211*	*243*	*179*	*229*	*264*	*209*
	5:00 p.m.–8:00 p.m.	8%	*3%*	7%	16%	3%	3%	12%
	10:00 p.m.–11:59 p.m.	34%	*37%*	6%	19%	24%	29%	3%
	All Other Hours	59%	*60%*	87%	65%	74%	67%	85%
Winter 2022/2023	*Charger/Vehicle Counts*	*153*	*579*	*336*	*202*	*303*	*699*	*241*
	5:00 p.m.–8:00 p.m.	7%	*3%*	7%	19%	5%	3%	15%
	10:00 p.m.–11:59 p.m.	33%	*37%*	7%	19%	22%	28%	6%
	All Other Hours	60%	*61%*	85%	62%	73%	69%	79%

Note: Blue shaded cells are each group's event window. Excludes evPulse away charging and PTR event days. Excludes Group B EVSE TOD participants due to the small count of participants on the rate.

Average hourly charging load during event hours is considerably lower than non-event hours across all cohorts, except TOD Group C participants. The average charging load of TOD Group C participants during Group B event hours of 5:00 p.m.– 8:00 p.m. is lower than during the Group C event window of 10:00 p.m.–11:59 p.m. (0.14 kW to 0.17 kW compared to 0.19 kW to 0.40 kW) (Table 16). Relative to Group A, non-TOD Group C participants have higher charging load during Group B event hours; the average charging demand during peak hours varies across event seasons but is similar to the average demand during all other hours (0.22 kW to 0.32 kW compared to 0.25 kW to 0.29 kW).

Table 16. Average Demand (kW) by Time Period on Event Days per Vehicle/Charger

Season	Time period	TOD			Non-TOD			
		Group A (Control)	Group B (evPulse)	Group C	Group A (Control)	Group B (EVSE)	Group B (evPulse)	Group C
Winter 2021/2022	*Charger/Vehicle Counts*	*11*	*210*	*74*	*152*	*154*	*281*	*150*
	5:00 p.m.–8:00 p.m.	0.16	0.16	0.14	0.41	0.11	0.15	0.28
	10:00 p.m.–11:59 p.m.	1.17	1.37	0.40	0.63	0.67	1.01	0.14
	All Other Hours	0.22	0.32	0.24	0.23	0.23	0.29	0.29
Summer 2022	*Charger/Vehicle Counts*	*49*	*211*	*243*	*179*	*229*	*264*	*209*
	5:00 p.m.–8:00 p.m.	0.16	0.09	0.14	0.34	0.05	0.09	0.22
	10:00 p.m.–11:59 p.m.	1.06	1.68	0.19	0.60	0.70	1.16	0.09
	All Other Hours	0.19	0.29	0.28	0.21	0.23	0.28	0.25
Winter 2022/2023	Charger/Vehicle Counts	153	579	336	202	303	699	241
	5:00 p.m.–8:00 p.m.	0.17	0.08	0.17	0.43	0.11	0.09	0.32
	10:00 p.m.–11:59 p.m.	1.25	1.75	0.25	0.65	0.79	1.28	0.18
	All Other Hours	0.24	0.30	0.31	0.22	0.28	0.33	0.26

Note: Blue shaded cells are each group's event window. Excludes evPulse away charging and PTR event days.

3.6 MANAGED CHARGING IMPACTS

In the following sections, we provide estimated charging load impacts due to the Residential Charging Pilot interventions across three event seasons: Winter 2021/2022, Summer 2022, and Winter 2022/2023. We provide additional details on data-cleaning and analysis methods in Appendix A.

The Residential Charging Pilot reduced an average of 0.37 kW of charging load per event hour per participant during the Winter 2021/2022 Event Season, 0.40 kW during the Summer 2022 Event Season, and 0.49 kW during the Winter 2022/2023 Event Season for EVSE participants. Table 17 presents modeled per-vehicle and total load impacts across the three event seasons. Due to the increasing participating population of EVs as well as growing per-vehicle impacts season-to-season, the Residential Charging Pilot reduced a total of 142 kW during event hours in the Winter 2021/2022 Event Season, 284 kW in the Summer 2022 Event Season, and 489 kW in the Winter 2022/2023 Event Season for EVSE participants.

Table 17. Average EVSE Event Demand Impacts per Charger by Event Season

Season	Total Vehicles/Chargers Enrolled at the End of the Event Season	Average Hourly Load Impact per Vehicle/Charger (kW)	Total Hourly Load Impact (kW)
Winter 2021/2022	379	0.37	142
Summer 2022	710	0.40	284
Winter 2022/2023	1,005	0.49	489

Note: Excludes evPulse channel participants and PTR event days.

The evaluation team chose not to include evPulse in the estimation of pilot impacts due to the lack of equivalency with the baseline charging provided by the control group, Group A. The control group was constructed entirely from EVSE channel participants and differs considerably from evPulse participants on several key characteristics. In addition to the differences identified in the charging pattern analysis presented above, we provide additional details on our equivalency analysis and estimates of evPulse impacts using a simple difference methodology in Appendix A. If the evPulse impacts from the simple difference calculation were included in our estimation of pilot impacts, the average hourly event impact per vehicle/charger would be 0.29, 0.32 and 0.34 for the Winter 2021/2022, Summer 2023 and Winter 2022/2023 season, respectively. The total hourly load impacts for the pilot would be 243 kW for the Winter 2021/2022 season, 375 kW for the Summer 2022 season, and 771 kW for the Winter 2022/2023 season.

- The size of the load impacts varied by treatment group, with Group C, whose event hours were later in the evening when there was more charging load to reduce, consistently achieving larger impacts. Group C impacts were nearly double Group B EVSE impacts, reaching as much as 0.62 kW per-charger compared to 0.34 kW during the Winter 2022/2023 Event Season. These differences in load impacts by participant group are not surprising given the findings from the charging pattern analysis that showed greater charging load for Group A during the Group C event hours compared to Group B hours. Table 18 provides the average baseline load (Group A charging load) for each treatment group. The baseline load during Group C event hours was double or close to double that of Group B EVSE across the three event seasons.
- Load impacts represented as a percentage of baseline load are relatively similar between the Groups B EVSE and C, though there is variation by season. During the Winter 2021/2022 Event Season, Group B's percent load impacts were slightly lower at 72% compared to Group C's percent load impacts of 76% (Table 18). During the Summer 2022 Event Season as well as Winter 2022/2023 Event Season, Group B's percent load impacts were higher than Group C's (84% vs. 80% and 77% vs. 72%, respectively). The percent load impacts of both winter seasons were less than the summer season.
- Across all three event seasons, Group C had nearly triple the total load impacts of Group B EVSE. The performance difference is due to the larger number of EVSE participants assigned to Group C and the greater amount of baseline load during the Group C event window, which allowed higher per charger load reduction (Table 18).
- The pilot load impacts of Group C TOD participants were nearly double that of non-TOD Group C participants. For the Winter 2022/2023 Event Season, we had enough participants to estimate separate load impacts by TOD enrollment status for Group C. TOD participants reduced an average of 0.76 kW of charging load compared to 0.41 kW for non-TOD participants during event hours (Table 18). Group A TOD enrollees had more charging load in the evenings, resulting in greater baseline load compared to Group A non-TOD. Load impacts as a percentage of baseline load are similar for TOD and non-TOD.

Table 18. Average EVSE Channel Event Demand Impacts per Charger and Group by Event Season

Season	Group	Total Vehicles/ Chargers Enrolled at the End of the Event Season	Average Hourly Baseline Load Per-Vehicle/ Charger (kW)	Average Hourly Load Impact per Vehicle/Charger (kW)	% of Load Impact	Total Hourly Load Impact (kW)
Winter 2021/2022	Group B (5:00 p.m.–8:00 p.m.)	157	0.38	0.27	72%	43
	Group C (10:00 p.m.–11:59 p.m.)	222	0.63	0.48	76%	107
	Total	**379**	**0.50**	**0.37**	**74%**	**142**
Summer 2022	Group B (5:00 p.m.–8:00 p.m.)	248	0.32	0.27	84%	67
	Group C (10:00 p.m.–11:59 p.m.)	462	0.64	0.51	80%	233
	Total	**710**	**0.50**	**0.40**	**81%**	**284**
Winter 2022/2023	Group B (5:00 p.m.–8:00 p.m.)	373	0.44	0.34	77%	127
	Group C (10:00 p.m.–11:59 p.m.)	632	0.86	0.62	72%	390
	Group C – TOD	376	1.06	0.76	72%	285
	Group C – Non-TOD	256	0.58	0.41	71%	105
	Total	**1,005**	**0.66**	**0.49**	**73%**	**489**

Hourly load impacts over the course of the event windows are relatively consistent with differences due to changes in the baseline load. Among Group B EVSE participants, baseline load increased slightly during the event window resulting in slightly greater average load impacts after the first hour. Group C's load impacts are lower during the second hour of the event window during the winter seasons primarily due to lower baseline load during the second hour (Table 19).

Table 19. Average EVSE Channel Demand Impact per Charger by Group, Event Season, and Event Hour

Group	Winter 2021/2022			Summer 2022			Winter 2022/2023		
	Average Hourly Baseline Load Per-Vehicle/ Charger (kW)	Average Hourly Event Impact per Vehicle/ Charger (kW)	% Impact	Average Hourly Baseline Load Per-Vehicle/ Charger (kW)	Average Hourly Event Impact per Vehicle/ Charger (kW)	% Impact	Average Hourly Baseline Load Per-Vehicle/ Charger (kW)	Average Hourly Event Impact per Vehicle/ Charger (kW)	% Impact
Group B (EVSE)									
Hour 1	0.34	0.25	74%	0.29	0.23	82%	0.40	0.30	76%
Hour 2	0.39	0.29	75%	0.32	0.27	85%	0.45	0.35	76%
Hour 3	0.41	0.28	68%	0.36	0.31	86%	0.48	0.37	77%
Average	**0.38**	**0.27**	**72%**	**0.32**	**0.27**	**84%**	**0.44**	**0.34**	**77%**
Group C (All)									
Hour 1	0.67	0.55	81%	0.63	0.51	80%	0.95	0.71	75%
Hour 2	0.59	0.41	70%	0.64	0.50	79%	0.77	0.53	68%
Average	**0.63**	**0.48**	**76%**	**0.64**	**0.51**	**80%**	**0.86**	**0.62**	**72%**
Group C – Non-TOD									
Hour 1	-	-	-	-	-	-	0.61	0.44	72%
Hour 2	-	-	-	-	-	-	0.55	0.38	70%
Average							**0.58**	**0.41**	**71%**
Group C – TOD									
Hour 1	-	-	-	-	-	-	1.18	0.89	75%
Hour 2	-	-	-	-	-	-	0.93	0.63	68%
Average	-	-	-	-	-	-	**1.05**	**0.76**	**72%**

Note: Group C All is the weighted average of Group C TOD and Non-TOD participants in the Winter 2022/2023 season.

The Residential Charging Pilot came short of PGE's planning assumption of 0.45 kW for the Winter 2021/2022 and Summer 2022 Event Seasons, reaching 83% and 89% of the goal, respectively. The pilot exceeded the goal for the Winter 2022/2023 Event Season. Across all event seasons, Group C consistently exceeded the planning goal, while Group B's load impacts were considerably lower than the planning assumption (Table 20). Group B's underperformance is a function of a much lower baseline load. Across all seasons, the average baseline load for Group B participants was lower than the planning load impact assumption. The increased performance of Group C across the seasons is due primarily to an increase in the baseline load, particularly during the Winter 2022/2023 Event Season.

Table 20. Average EVSE Channel Event Baseline and Demand Impacts per Charger and Group by Event Season

Season	Group	Average Hourly Baseline Load per Vehicle/Charger (kW)	Average Hourly Load Impact per Vehicle/Charger (kW)	Planning Assumption (kW)	Percent of Planning Assumption Achieved
Winter 2021/2022	Group B (5:00 p.m.–8:00 p.m.)	0.38	0.27	0.45	61%
	Group C (10:00 p.m.–11:59 p.m.)	0.63	0.48		107%
	Total	**0.50**	**0.37**		83%
Summer 2022	Group B (5:00 p.m.–8:00 p.m.)	0.32	0.27		60%
	Group C (10:00 p.m.– 11:59 p.m.)	0.64	0.51		112%
	Total	**0.50**	**0.40**		89%
Winter 2022/2023	Group B (5:00 p.m.–8:00 p.m.)	0.44	0.34		75%
	Group C (10:00 p.m.– 11:59 p.m.)	0.86	0.62		137%
	Group C – TOD	1.07	0.76		168%
	Group C – Non-TOD	0.58	0.41		92%
	Total	**0.66**	**0.49**		108%

3.7 EVENT OPT-OUTS

Our load impact analysis showed that average hourly charging load shift is highly dependent on the amount of baseline load that is available to shift. While the pilot shifted a large amount of load relative to the baseline for all groups, a small percentage of charging still took place. In this section, we further explore the frequency of customers opting out of events by charging during their assigned event window.[24]

Based on analysis of charging interval data, Group C had the highest average percent of participants opt out per event while Group B EVSE had the lowest across the three seasons. To better understand opt-out behaviors, we calculated, for each event day, the share of participants who charged during at least a portion of the event hours. Table 21 shows the minimum, maximum, and average opt-out rates. Opt-out rates vary by season and group. On average, between 2% and 19% of participants opted-out of events by charging their EVs. The maximum opt-out rate occurred on December 31, 2021, when one-third of Group C participants charged during their 10:00 p.m.–11:59 p.m. event window. On average, Group C had the highest average and maximum opt-out rates. Group B EVSE had the lowest average opt-out rates whereas Group B evPulse had the lowest maximum opt-out rates. During the Summer 2022 and Winter 2022/2023 Event Seasons, Group B evPulse participants did not have a single event day without an opt-out.

Table 21. Average Percent of Participants that Charge During an Event

Season/Group	Maximum Percentage of Participants that Charge During an Event	Average Percentage of Participants Charging During an Event	Minimum Percentage of Participants Charging During an Event
Winter 2021/2022			
Group B EVSE	23%	7%	0%
Group B evPulse	16%	12%	0%
Group C	33%	12%	0%
Overall	33%	10%	0%
Summer 2022			
Group B EVSE	15%	2%	0%
Group B evPulse	14%	8%	5%
Group C	27%	14%	0%
Overall	27%	8%	0%
Winter 2022/2023			
Group B EVSE	24%	4%	0%
Group B evPulse	11%	6%	3%
Group C	29%	19%	0%
Overall	29%	10%	0%

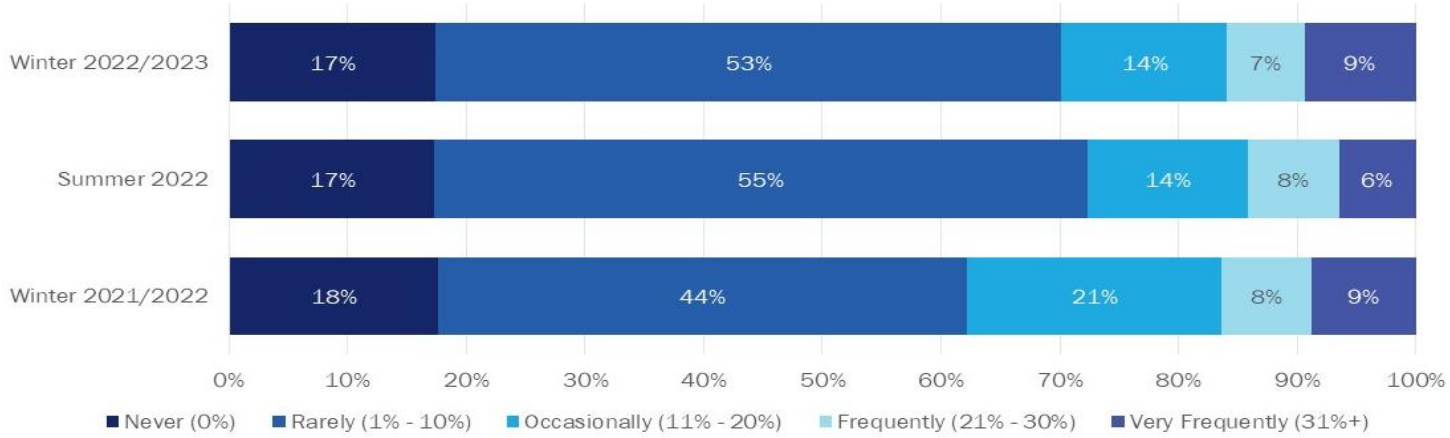
Note: Charging during an event is defined as having a greater than 0 usage for at least one hour during the event hours. Excludes evPulse away charging and PTR event days.

Not all participants opt out of the events. A majority never or rarely opted out while a small percentage did so frequently. Across all three seasons, between 17% and 18% of participants never opted out of a single event, and

[24] Opt-outs are defined as participants with greater than zero consumption during at least one hour of their PGE event window. We received hourly data for the EVSE channel and 15-minute data for evPulse. Given the level of data aggregation, we cannot identify customers who charged for just a few minutes. In future analyses, we could explore setting a minimum amount of charging during the hour to be classified as an opt-out. For evPulse, away charging is excluded since charging is not stopped when the vehicle is not at home. Additional information on the opt-out methodology is included in Appendix A.

between 44% and 55% of participants opted out of less than 10% of all events (Figure 26). A small share of participants—between 14% and 17% depending on the event season—opted out of 21% or more of event days.

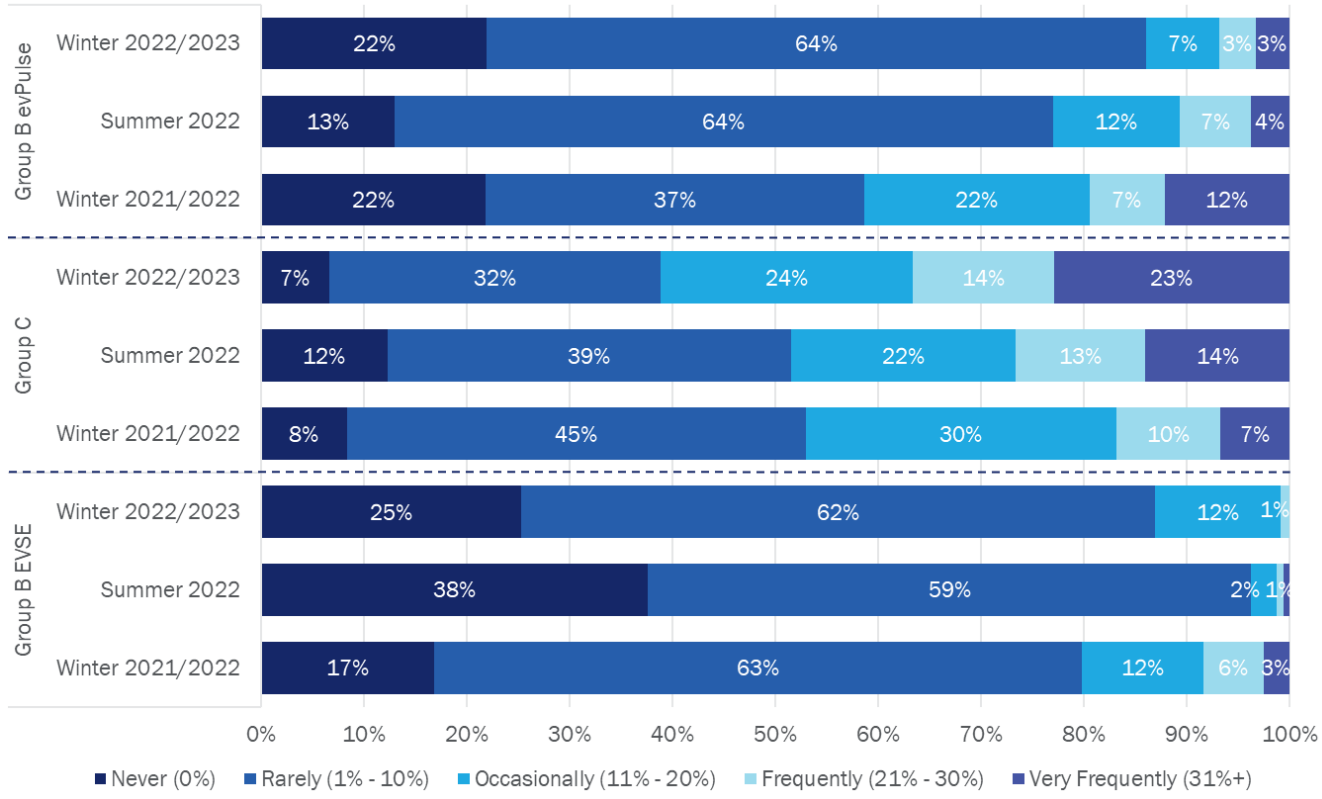
Figure 26. Participant Event Opt-out Rate by Season



Note: Excludes evPulse away charging and PTR event days.

Figure 27 further breaks down the percent of participants who opted out of events by participant group and season. Group C participants were more likely to opt out, while Group B EVSE participants were least likely. No more than 9% of Group B EVSE participants opted out of more than 20% of events. In contrast, at least 17% and as many as 37% of Group C participants opted out of 20% of events. A much higher share Group B EVSE participants never opted out compared to Group C Participants.

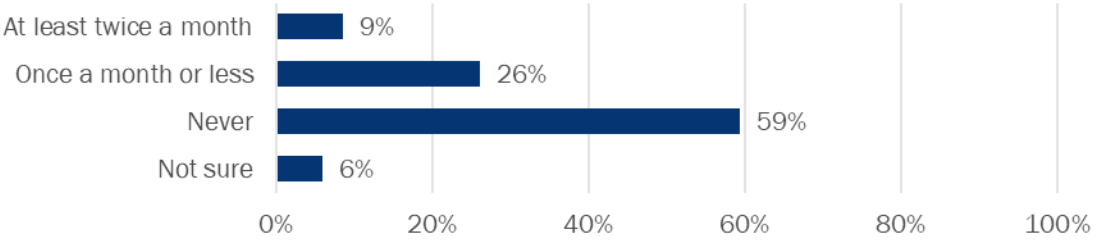
Figure 27. Participant Event Opt-out Rate by Group and Season



Note: Excludes evPulse away charging and PTR event days.

A majority of surveyed Residential Charging Pilot participants reported never opting out of events, which is at odds with the results of charging data opt-out analysis. When asked how often they opted-out or actively charged during events, nearly three-fifths of participants (59%) reported never opting out during the Winter 2022/2023 Event Season (Figure 28). The charging analysis found that just under one-fifth of participants (18%) never charged during their event window. This discrepancy could be due to recall error as the charging analysis found that 44% charged rarely (i.e., 1% to 10% of events). It can be difficult to recall an action that is taken rarely or that may have been done by another household member. It is also possible that some of the charging we identified through the charging data analysis was due to a technological failure, such as when a charger gets disconnected from program control. Pilot implementation partners reported that disconnected chargers were a common issue. Unfortunately, the charging data does not allow us to distinguish between event window charging that is due to deliberate customer behavior versus technological failures. Further exploring reasons for more persistent opt-out behaviors can help identify the underlying causes to help minimize future opt-outs and maximize program performance.

Figure 28. Survey Respondent Reported Event Opt-Out Frequency Winter 2022/2023 Season (n=723)



Note: This question excluded those in Group A (control) who did not experience DR events.

3.8 PEAK PERIODS

Figure 29 illustrates the percent of charging consumption by hour type for each Pilot group. Charging is broken down by on-peak (5:00 p.m.–9:00 p.m.), and off-peak/mid-peak (9:00 p.m.–5:00 p.m.).[25] PGE's designation of peak hours does not align exactly with the pilot's event windows. PGE's peak period includes 8:00 p.m.–9:00 p.m., but the pilot does not control the charging of any group during this hour.

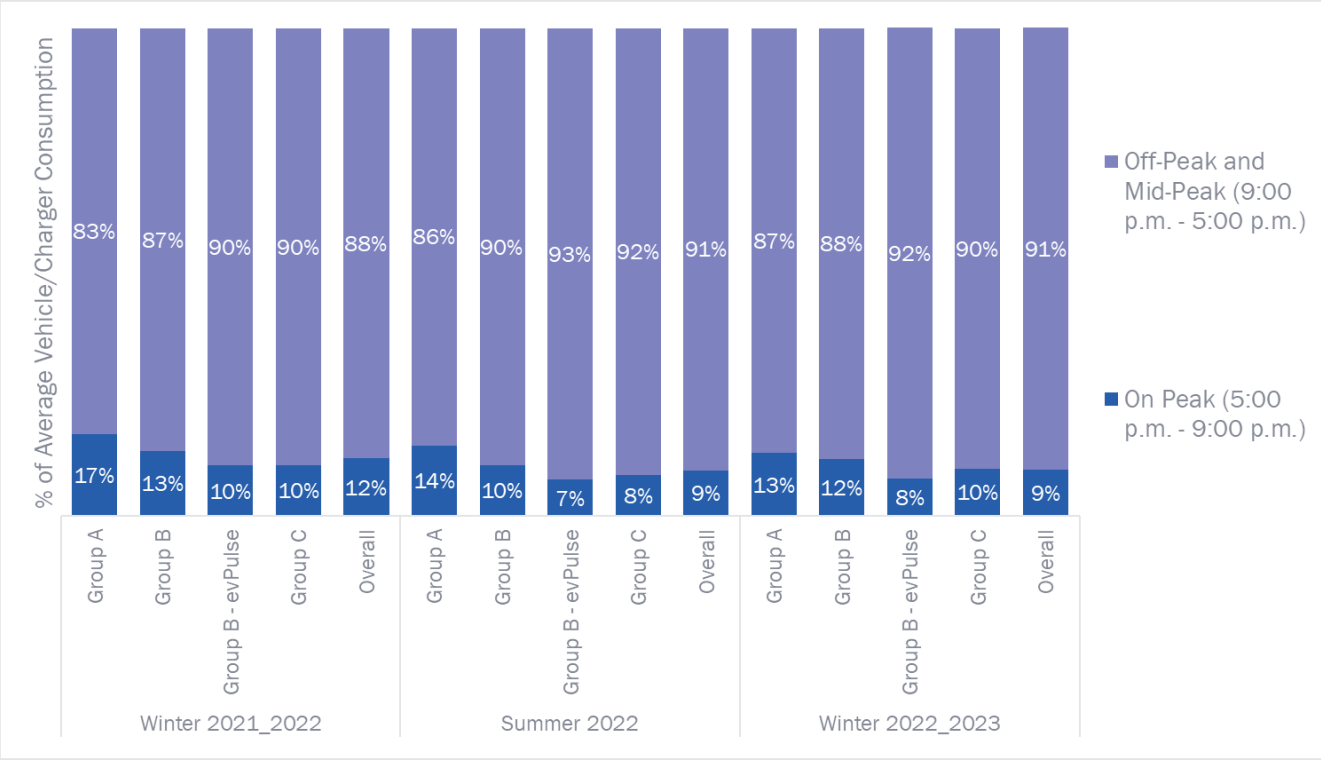
Group A, the control group, conducted a greater share of its EV charging during PGE's system peak period than any of the treatment groups. Group B (EVSE) had the second highest charging percentage during on-peak hours, which is likely due to the end of the Group B event window at 8:00 p.m., which is during peak hours.

Group B evPulse had the lowest percentage of on-peak consumption. Slightly under half of evPulse participants are enrolled in TOD, which encourages them to charge outside of the full peak hours of 5:00 p.m.–9:00 p.m. Group B evPulse.

Group C, which also has a higher percentage of TOD participants, has the second lowest usage during on-peak hours. This pattern suggests that participants are shifting their charging overnight rather than earlier in the day to accommodate both TOD and their event window from 10:00 p.m. to 11:59 p.m.

[25] Peak periods are defined based on PGE's residential TOD plan: https://portlandgeneral.com/about/info/pricing-plans/time-of-day.

Figure 29. Residential Charging Pilot Percent Consumption by Hour Type and Group

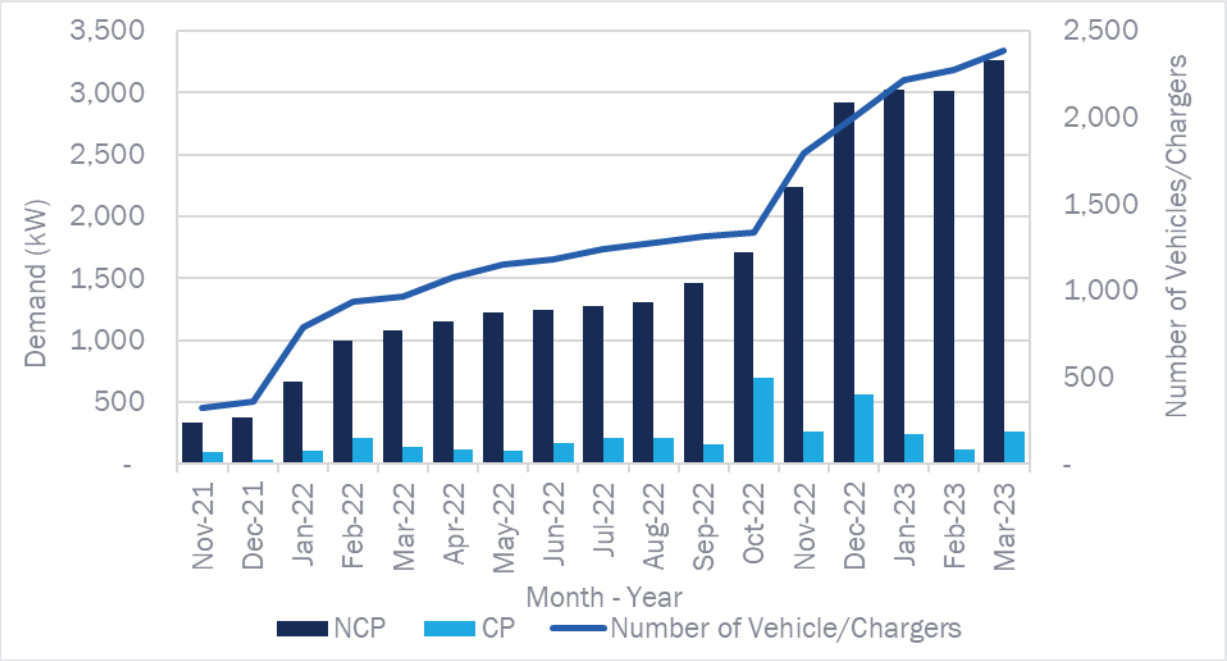


Note: Excludes evPulse away charging and PTR event days. Overall is inclusive of Group A.

3.9 NON-COINCIDENT PEAK

EV charging peak load is not frequently coincident with PGE system peak load. Figure 30 summarizes the non-coincident peak load and coincident peak load using monthly system peak hours. Throughout the study period, the non-coincident peak (NCP) load of Residential Charging Pilot participants increased from 336 kW to 3,260 kW**.** The increase in NCP load is due to more chargers and vehicles enrolling in the pilot. In addition to the non-coincident peak, the evaluation team also investigated the system coincident peak (CP), which represents the charging load peak contribution during PGE's system peak hours. The coincident peak load ranges from 40 kW (364 vehicles/chargers) to 699 kW (1,338 vehicles/chargers), peaking in October 2022.

Figure 30. Residential Charging Pilot NCP and CP



Note: Excludes evPulse away charging and PTR event days.

4. BUSINESS CHARGING REBATES PILOT FINDINGS

This section provides findings from in-depth interviews conducted with Business Charging Rebates Pilot participants and a charging pattern analysis conducted by the team.

4.1 PILOT PARTICIPATION CHARACTERISTICS

Participation in the Business Charging Rebates Pilot has been relatively steady but showed signs of increasing in 2023. In total, 163 Level 2 and four DCFC ports were installed by 29 participating organizations across 42 sites in PGE's services territory during the evaluation period (Table 22). Pilot staff mentioned that changes made to the pilot in November 2022, including expanding increased Level 2 charging rebates for all multifamily customers, installation rebates, and DCFC rebates, has resulted in increased customer engagement, which may be reflected in the increase in overall pilot participation in 2023.[26]

Table 22. Summary of Participation in the Business Charging Rebates Pilot by Installation Year

	2020	2021	2022	2023	Total
Number of Level 2 (Ports)	2	53	52	56	163
DCFC (Ports)	0	0	0	4	4
Participating Organizations	1	8	8	12	29
Participant Sites	1	14	8	19	42

Pilot participant sites are generally associated with public or multifamily sites, with many being multiuse sites. Most sites were for fleet, public, or workplace charging (12 of 42) or public charging only (12 of 24), with about two-fifths (18 of 42) being multiuse sites (Table 23). Few sites were dedicated exclusively to fleet or workplace charging.

Table 23. Business Charging Rebates Pilot Participant Site Use

Site Use	Site Count
Fleet, Public, and Workplace	12
Public Only	12
Multifamily Only	7
Workplace and Public	5
Workplace Only	4
Fleet Only	1
Fleet, Multifamily, Public, and Workplace	1
Total	**42**

Many Pilot participant sites are located in underserved communities. The evaluation team mapped participant sites to census tracts identified by PGE as containing high proportions of underserved customers – as defined by HB2165 - and found that about three-quarters (32 of 42) of participant sites were located in one or more of the underserved community types, including 108 chargers and 134 charging ports (Table 24). Of the underserved community types,

[26] In November 2022, the pilot increased rebates to $2,300 for multifamily properties, regardless of income eligibility. At that time, the pilot also added new rebates for Level 2 make-ready infrastructure (80 percent of cost up to $6,000 per port), added rebates for DCFCs, and added the ability to reserve rebates for up to 12 months to increase certainty to customers through potentially long development processes. Rebates for make-ready infrastructure and DCFCs were fully reserved in April 2023 and have since been removed from the pilot.

participating sites were most frequently located in communities with high proportions of renters (24 of 42) and communities adversely harmed by environmental health hazards (18 of 42).

Table 24: Business Charging Rebates Pilot Participant Sites, Chargers, and Ports in Underserved Communities (PGE GIS Analysis)

Underserved Community Criteria	Sites	Chargers	Ports
Area with high proportion of renters	24	85	107
Environmental health hazard area	18	72	86
Area with high proportion of multifamily	13	56	75
Communities of color	14	45	55
Low-Income area	10	19	27
Rural area	0	0	0
Tribal area	0	0	0
Any Underserved Community	**32**	**108**	**134**

Note: Underserved community criteria are not mutually exclusive.

The 10 interviewed Pilot participants were generally representative of the participant population (Table 25). Apart from one school property, the group is composed entirely of commercial and multifamily properties. Interviewed participants represent a range of charging end uses. All participants reported that the chargers installed through the program had been in operation for at least six months, with three indicating that they had chargers installed prior to participating that did not qualify for rebates.

Table 25. Summary of Business Charging Rebates Pilot Interviewee Characteristics

Type of Organization	Site Type			Ports Before Participation	Ports After Participation	Approximate Charger Operational Time
	Public	Private	Fleet			
Office Building	Yes	Yes	No	4 Level 2	8 Level 2	12 months
Auto Dealership	No	Yes	No	1 Level 2	2 Level 2; 4 DCFC	8 months
Secondary School	No	No	Yes	0	1 Level 2	9 months
Fitness Center[a]	Yes	Yes	Yes	0	1 Level 2	8 months
Office Building	Yes	Yes	Yes	0	4 Level 2	24 months
Multifamily Building	No	Yes	No	0	2 Level 2	6 months
Multifamily Building[b]	No	Yes	No	0	2 Level 2	30 months
Multifamily Building	No	Yes	No	Unknown	21 Level 2	13 months
Multifamily Building	No	Yes	No	0	4 Level 2	7 months
Multifamily Building	No	Yes	No	0	8 Level 2	8 months

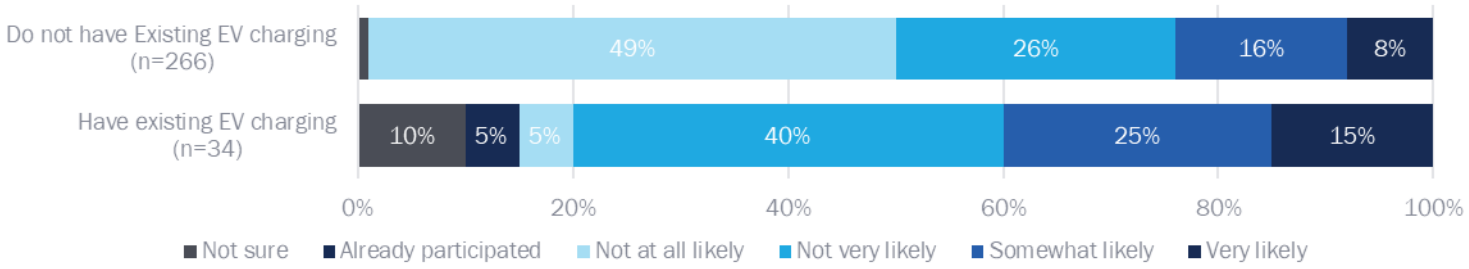
[a] This interviewee installed the EVSE and applied for the rebate on behalf of the participating property.
[b] This participant was a resident of a multifamily property that installed charging at their private parking lot.

4.2 PILOT AWARENESS AND ENROLLMENT

Commercial customers in PGE's service area expressed moderate levels of awareness and interest in participating in the Business Charging Rebates Pilot. Results from PGE's 2023 General Business Survey show that 7% of commercial

customers currently have EV charging on-site.[27] Survey results showed that 35% of customers with EV charging and 14% of customers without EV charging are aware of PGE's Business Charging Rebates Pilot. The few customers who have EV charging onsite and are aware of the pilot are nearly twice as likely to consider participating in the pilot than those who do not have onsite charging (40% vs. 24%, respectively; Figure 31).

Figure 31. Likelihood of Participating in PGE's Business Charging Rebates Pilot Among Those Who Are Aware of the Pilot



Business Charging Rebates Pilot marketing and outreach appear to be sufficient, given the pilot's budget. The Business Charging Rebates Pilot relies on customers visiting the PGE website to learn about rebates or being informed about the pilot by PGE's KCMs, business outreach personnel, or Tech Sales staff. At the time of interviews with pilot staff, the pilot was on track to exhaust funding for 2023 without the need for any additional outreach. Aligning with how the pilot is marketed, interviewed participants recalled learning about the pilot from a PGE account representative (four mentioned), PGE's website, EVSE vendors, and neighboring properties (two mentions each).

More coordination between other PGE non-residential offerings could help increase cross-pilot participation. Pilot staff noted they have not seen non-residential customers come over from other PGE offerings such as Fleet Partner or Energy Partner Pilots. Additionally, customer outreach staff wanted to be more informed about PGE's TE offerings (i.e., Fleet Partner Pilot and Drive Change Fund) to ensure customers they work with are aware of these offerings. In interviews with Fleet Partner Pilot staff (discussed below), the need for more information about other PGE offerings was noted and it was suggested that the KCMs and business outreach staff would be the best sources of such information as they are closest to PGE's commercial customers.

The addition of the pilot rebate reservation has been successful. In November 2022, Pilot staff introduced a reservation system as part of the pilot redesign, which allowed participants to reserve rebates for up to 12 months for those who were going through long development processes. This reservation system has helped staff with planning as it provides insight into which customers were progressing through the pipeline and allows staff to better advise customers on how to submit required documentation to receive rebates. While the reservation system allows staff to see withdrawals from the pilot, none have been reported.

Most participants decide to install charging to provide a new amenity for end users. Seven participants, four multifamily and three commercial office buildings, mentioned that they installed charging on their properties to provide a convenient and safe means of charging for themselves and their tenants (five mentions) or patrons (three mentions). Participants were also motivated to install charging to take first-mover advantage by becoming one of the first companies to adopt EV technology in their industry (two mentions), meet their organization's sustainability goals (two mentions), or expand their fleet charging capacities (one mention).

Incentive levels are sufficient, but most participants indicate they would have installed charging without PGE's assistance. Most participants (7 of 10) mentioned that they would have purchased and installed the chargers without the rebates they received. Of those seven participants, four offered additional motivations for completing the pilot. One

[27] Based on results analyzed from three questions from a PGE-fielded survey with a general population of commercial customers in Q2 2023.

stated that they would have had to move forward with their projects due to new legislation that placed new emission standards on diesel vehicles, two participants mentioned residents' need for on-site charging, and one participant noted auto manufacturer requirements for auto dealerships. Only one participant, a small business, reported that they would not have been able to install charging without the pilot rebates.[28]

4.3 PILOT PARTICIPATION PROCESS

More resources and support for improving the collection and tracking of charger information are needed. In addition to the reservation system, pilot staff also introduced a new online application that allowed participants to submit charger information, other required participant information, and supporting documents (including invoices, W-9s, and charger nameplate photos) more easily. Pilot staff, however, reported challenges completing the build-out of a tool to improve tracking of serial numbers. Data are currently being collected using an Excel-based spreadsheet that lacks features of a data tracking system needed to manage participant information efficiently and accurately. Additionally, staff noted some challenges coordinating with charger vendors to verify serial numbers.

Participants have concerns about agreeing to some of the pilot's participation requirements. Participants mentioned concerns about what they would be liable for if they failed to maintain and operate the chargers before the end of the 10-year period (2 mentions) and about sharing charging data with PGE due to privacy concerns (one mention). Additionally, four participants mentioned challenges with PGE's qualified chargers, including having too many choices and not having the expertise to select chargers best suited for their property, or a lack of vendors carrying sufficient quantities of qualified chargers.

Participants encountered minor issues during the charger procurement and installation process. Four participants experienced delays due to long lead times for equipment deliveries (two mentions), while other participants had issues with a transformer upgrade and a prolonged period of freezing weather (one mention each). The six remaining interviewed participants indicated the installation process was easy and straightforward. However, one of these participants, a multifamily property, struggled to figure out the installation process on their own and suggested that PGE could provide more technical support.

Network connection issues and software issues are the most common issues with the chargers. Participants recalled that their charger issues were most often related to the software interfaces of their charging equipment or the network connection between their charging equipment and cell towers (3 mentions each). Participants stated that these issues were easily resolved. The remaining participants reported that they faced no issues with chargers.

4.4 END USER CHARGING PREFERENCES AND BEHAVIORS

End user charging typically occurs during standard business hours or evenings and charger utilization levels are generally meeting expectations. Apart from multifamily properties with peak usage during the evenings (five mentions), charging at most properties occurs throughout the day (five mentions). Most participants mentioned that end user charger utilization levels are meeting their expectations (eight mentions). One participant mentioned that charger utilization levels are exceeding expectations, with one participant being unsure about the current usage.

Most participants are not exacting payment from their end users for the use of charging stations. All five multifamily participants reported that homeowners and tenants who use the chargers are charged as part of their monthly utility bills. One participant, an office building, mentioned that the first two hours of charging are free, after which users pay a

[28] The interviewed participants are likely to be early adopters of EV charging. We will continue to explore rebate levels in our 2024 participant research.

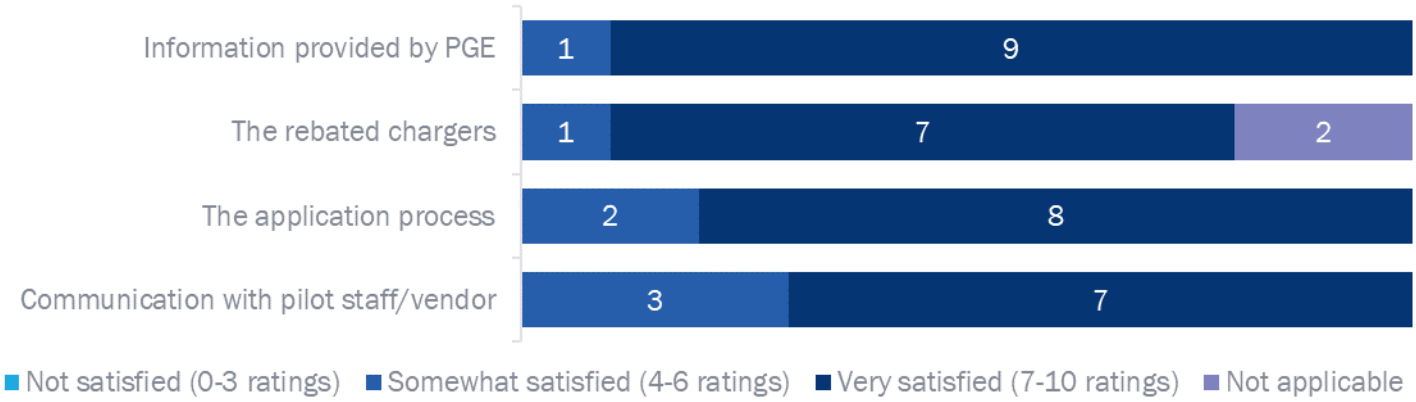
usage fee based on a fixed dollar-per-hour rate and an additional idle fee through their charger vendor's mobile app. The remaining participants mentioned that they are providing charging as a free service to all users.

Most Pilot participants are interested in managed charging but have concerns. Most (7 of 10) participants expressed interest in allowing PGE to manage on-site charging if they could get more information about benefits and requirements. Participants expressed concerns about charging interruptions or restrictions impacting end users. Participants suggested that including an option to manually override charging restrictions (two mentions), and more educational outreach and incentives (one mention each) may address these concerns.

4.5 PILOT PARTICIPANT SATISFACTION

Pilot participants are satisfied with the Business Charging Rebates Pilot. Nearly all (9 of 10) interviewed Pilot participants indicated that they were very satisfied with the information provided by PGE and the chargers they installed (Figure 32). While most participants were very satisfied with their communications with pilot staff or vendors, a few were only somewhat satisfied because of delays in getting pre-approval or assistance with their application from pilot staff, or inconsistent communication from their vendor while repairing their chargers. Two participants did not have direct experience with their chargers and were unable to provide a rating.

Figure 32. Participant Satisfaction with Business Charging Rebates Pilot (n=10)



4.6 BUSINESS CHARGING PATTERN ANALYSIS

For the business charging pattern analysis, the comprehensive database of charging data collected from Pilot participants was transformed by PGE into time series data that was then used to develop average aggregated load curves for participants in the Business Charging Rebates Pilot. We developed average hourly electricity consumption load curves and explored charging patterns overall and by site use. About three-quarters (22 of 29) participants had available data during the reporting period, accounting for four-fifths (33 of 42) of charging sites. Of the participants with available data, two-fifths (13 of 33) were missing data for at least one of their enrolled chargers. More information on the available data is included in Appendix B. It should be noted that across all Pilot participants there was only one DCFC session recorded which was excluded from the analysis.

Across the 112 charging ports at the 33 sites with available data, 24,898 charging sessions were completed from January 2021 through the end of August 2023 in the Business Charging Rebates Pilot. Across all sites and site uses, the average charging duration was just under three hours, and the average plug duration per session was nearly five hours (Table 26). The average electricity dispensed per session was 13.22 kWh. The only site used for fleet charging

had the highest average charge and plug duration (over 12 hours) as well as the highest average electricity dispensed (45 kWh). Variation in sessions across site types was observed (shown in Appendix B).

Table 26. Business Charging Rebates Pilot Session Summaries by Site Use

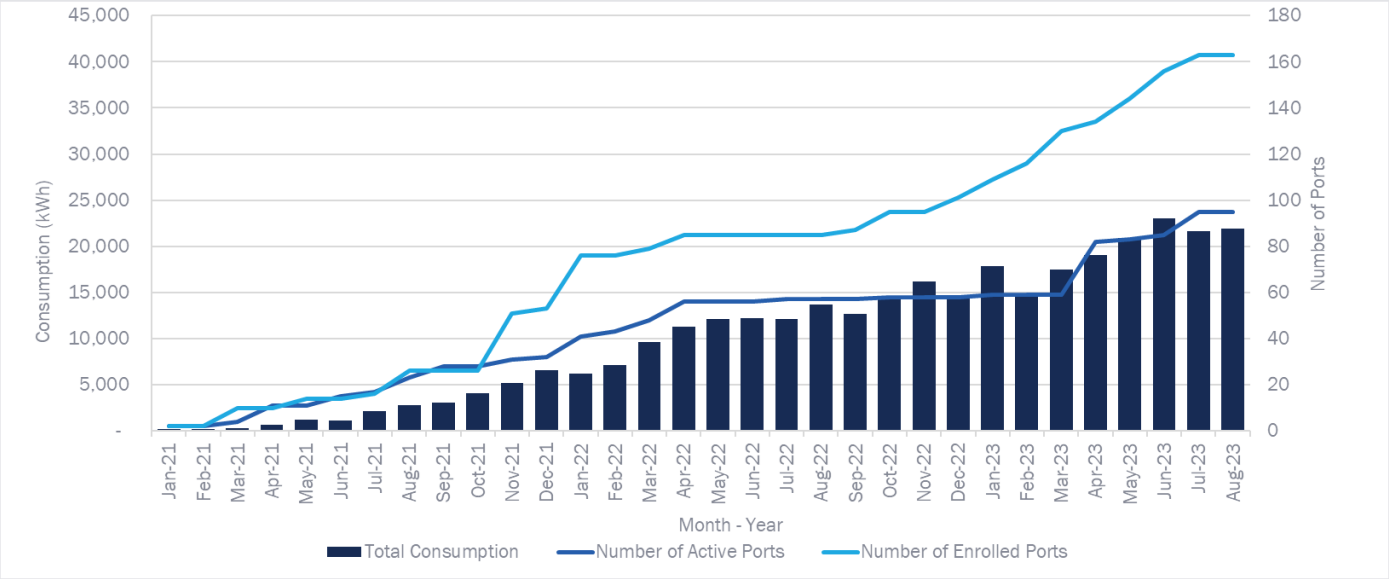
Site Use	Number of Sites	Number of Charger Ports	Number of Sessions	First Charge	Last Charge	Average Charge Duration (hrs.)	Average Plug Duration (hrs.)	Average Electricity Dispensed (kWh)
Fleet, workplace, and public	10	37	14,897	3/29/2021	9/1/2023	2.54	4.00	11.23
Public	12	29	1,643	11/23/2021	9/1/2023	3.62	4.60	19.73
Multifamily	5	10	303	12/31/2020	9/1/2023	3.61	10.27	27.28
Fleet, multifamily, workplace, and public	1	18	6,786	9/5/2021	8/31/2023	2.78	5.77	13.58
Workplace	2	10	889	3/29/2022	9/1/2023	3.67	5.82	18.25
Workplace and public	2	4	137	4/3/2023	8/31/2023	3.49	6.56	13.94
Fleet	1	4	243	5/31/2023	9/1/2023	12.09	15.19	45.07
All	**33**	**112**	**24,898**	**12/31/2020**	**9/1/2023**	**2.83**	**4.79**	**13.22**

4.6.1 CONSUMPTION AND CHARGING PATTERNS

Aggregated monthly energy consumption among Pilot participants increased from January 2021 to August 2023, peaking at 23 MWh in June 2023, as the number of charging ports increased. Figure 33 shows the total consumption per month across all sites with data as well as the number of active charging ports with data.[29] As anticipated, the general trend shows that monthly energy consumption increased as ports were added. From May 2022 to March 2023, the number of active ports stayed relatively constant, but consumption continued to increase, suggesting there was an intensification of use per port during that time.

[29] There were 33 sites with available session data; however, one of these sites had insufficient interval data (<24 hours of data).

Figure 33. Business Charging Rebates Pilot Monthly Energy Consumption



Note: A port is considered active between its first and last recorded charging session. A port is considered enrolled based on its install and retirement date.

The average charging load for all the Business Charging Rebates Pilot sites combined is plotted in Figure 34. The average load profile starts to ramp up around 6:00 a.m. and then gradually decreases after 10:00 a.m. We grouped and analyzed Business Charging Rebates Pilot participants by site type and investigated the usage pattern differences between these groups.

The average daily consumption varies considerably by site use; however, due to the relatively small number of sites, this may be due to the charging of specific Pilot participants rather than site use (Figure 35). Sites used for fleets, workplace, and mixed usage generally have peaks during working hours, while public and multifamily sites appear to be more evenly distributed throughout the day. The load shape representing only fleet charging is from a single site and has the highest mean hourly consumption reaching over 2.5 kW around 10:00 a.m.

Figure 34. Business Charging Rebates Pilot Average Load Curve (n=32)

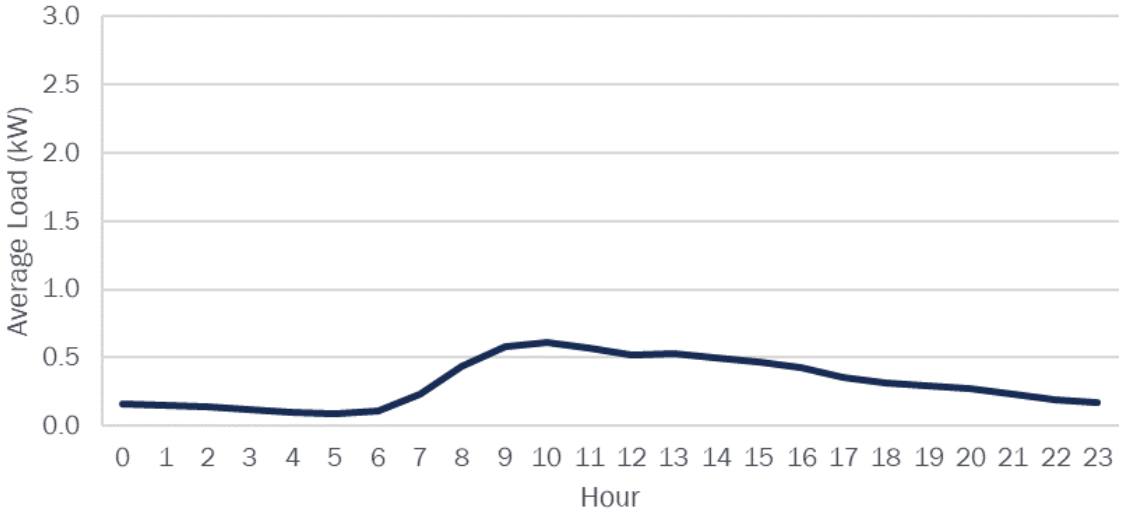
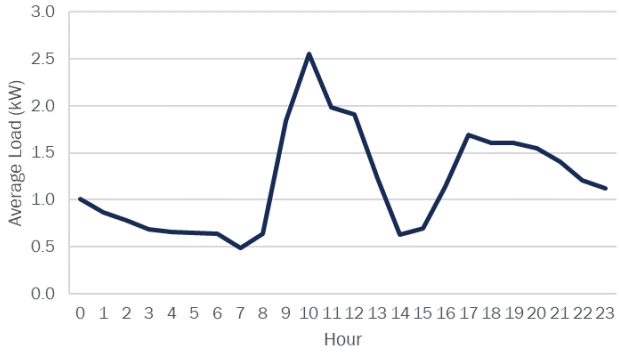
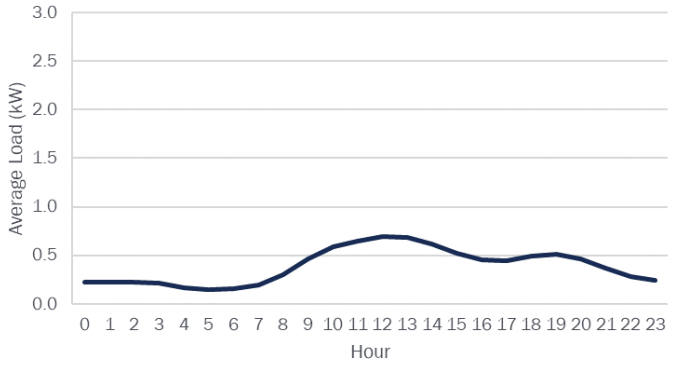
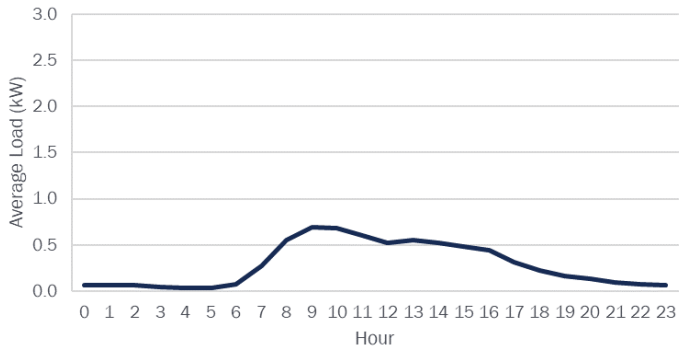


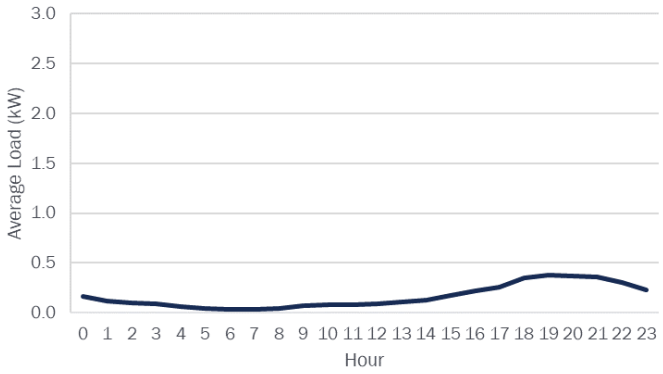
Figure 35. Business Charging Rebates Pilot Average Load Curve by Site Use

Fleet (n=1)	Fleet, Multifamily, Workplace, and Public (n=1)
	

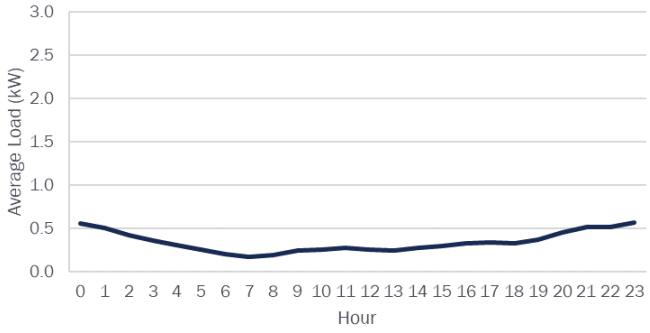
Fleet, Workplace, and Public (n=10)



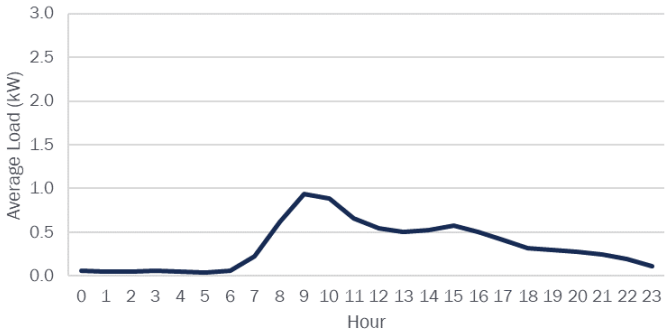
Multifamily (n=4)



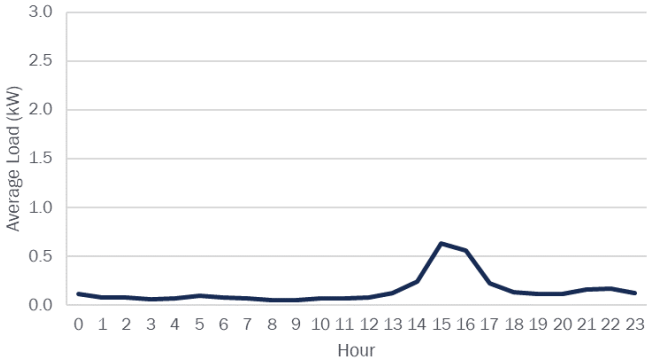
Public (n=12)



Workplace (n=2)



Workplace and Public (n=2)



4.6.2 PEAK IMPACT

Of the Business Charging Rebates Pilot sites with data, 11 were enrolled on a standard rate, PGE's Schedule 32. The remaining 21 sites were enrolled on a TOU rate, either PGE's Schedule 83 (16), Schedule 85 (4), or Schedule 38 (1).

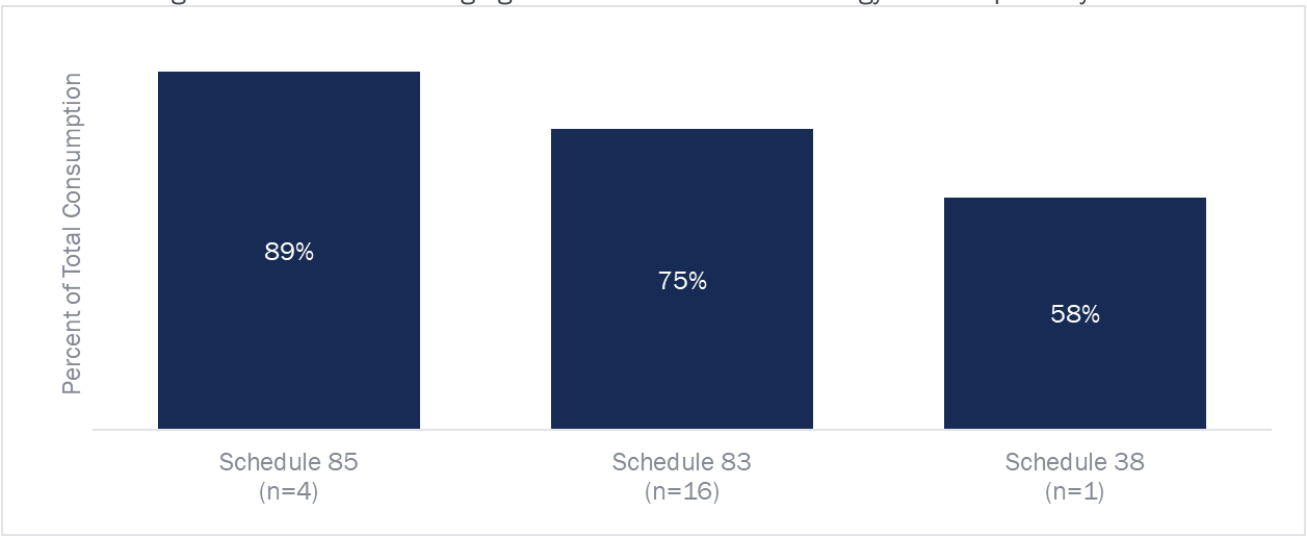
Table 27. Business Charging Rebates Pilot Sites Use and Rates

Rate	Site Use	Number of Sites
Schedule 32	Fleet; Workplace; Public	2
	Multifamily	3
	Public	3
	Workplace	1
	Workplace; Public	2
Schedule 38	Fleet	1
Schedule 83	Fleet; Multifamily; Workplace; Public	1
	Fleet; Workplace; Public	6
	Multifamily	1
	Public	8
Schedule 85	Fleet; Workplace; Public	2
	Public	1
	Workplace	1

Note: Rate designation is defined by current rate. It is possible that sites were on a different rate at other points in time during the reporting period. The table only shows sites that had available session data.

Across all TOU schedules, more than half of total consumption occurred during on-peak hours. Sites on Schedule 85 had the highest percentage of their total consumption occur during peak hours (89%) compared to sites on Schedule 83 (75%) and Schedule 38 (58%) (Figure 36). Due to the relatively small number of sites, this may be due to charging at specific sites rather than trends of participants enrolled in each rate.

Figure 36. Business Charging Rebates Pilot On-Peak Energy Consumption by Rate

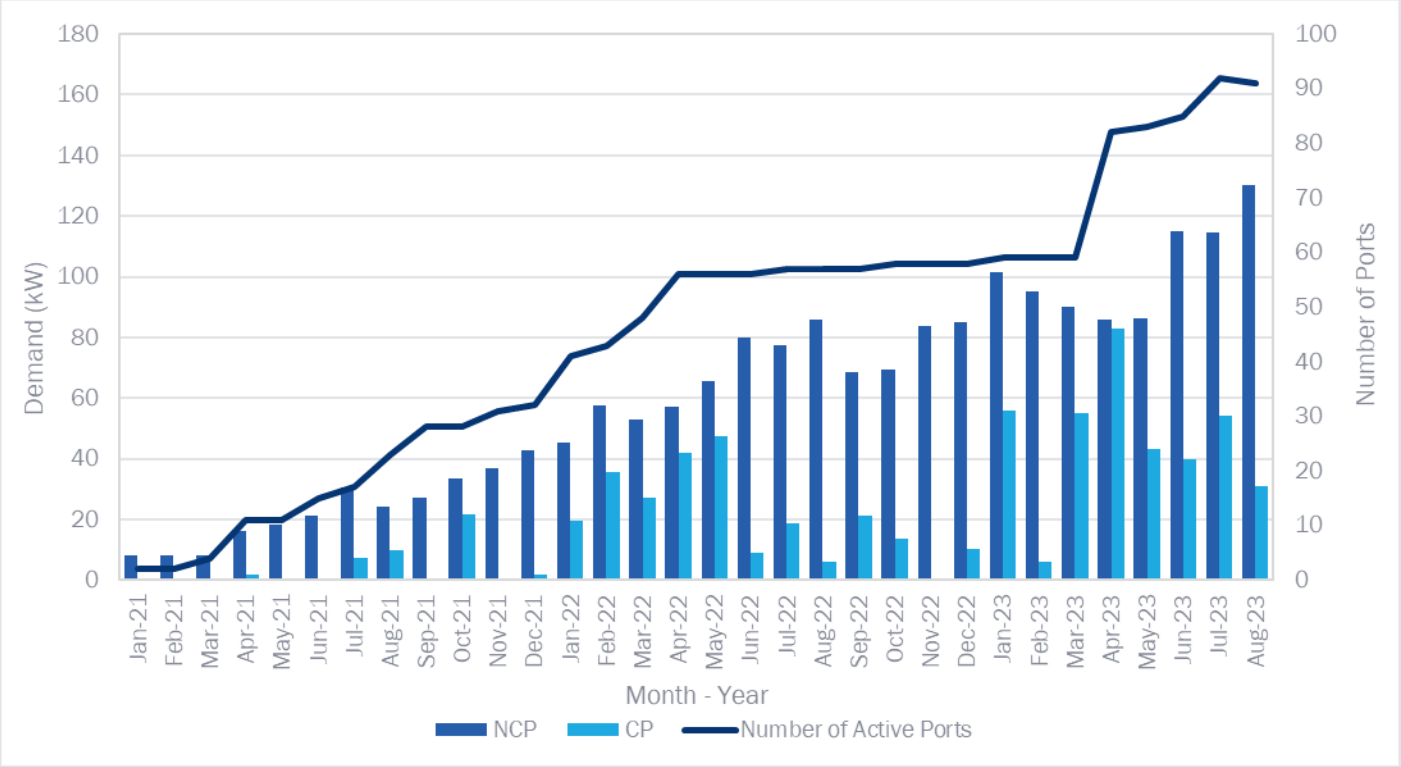


Note: Rate designation is defined by current rate. It is possible that sites were on a different rate at other points in time during the reporting period. In this figure, "n" is the number of sites.

Throughout the study period, the non-coincident peak (NCP) load of Business Charging Rebates Pilot sites increased. The NCP increases from 8 kW (2 active charging ports) to a peak of 130 kW (91 active charging ports) as additional sites and ports are activated (Figure 37). In addition to the NCP, the evaluation team also investigated the system

coincident (CP), which represents the charging load peak during PGE's system peak hours. Our analysis shows that peak charging load does not frequently coincide with PGE system peak load.

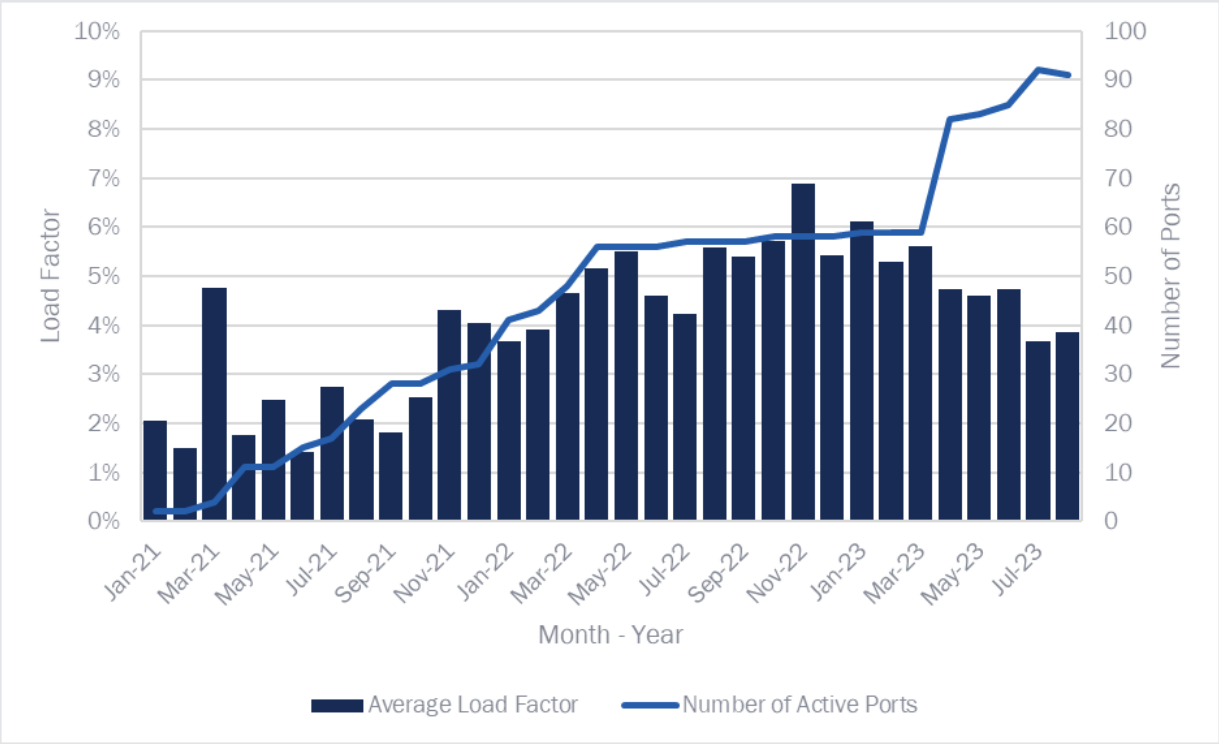
Figure 37. Business Charging Rebates Pilot Coincident and Non-Coincident Peak Load



The load factor of all charging generally increased until November 2022 but then steadily decreased through August.[30] During the study period, load factors ranged from 1% on June 2021 to 7% in November 2022, with an average load factor of 4% (Figure 38). Low load factors indicate that the average consumption is a very small percentage of the maximum consumption per site meaning that there are periods of very high usage but a relatively low rate of utilization. The decrease in load factors over time is likely due to new ports and sites coming online that had lower utilization rates relative to their maximum consumption.

[30] The load factor is the ratio of average charging load to the maximum charging load over a given period of time. Here the load factor is calculated as the average charging load divided by the maximum load averaged across sites for each month of the study period.

Figure 38. Business Charging Rebates Pilot Load Factor per Month



4.6.3 CHARGER UTILIZATION

Port utilization rates varied greatly between site types, with most site types showing low utilization. Port utilization is reported in two ways. The first is charge utilization, which identifies the percentage of time that the port is actively in use, relative to the time it is available. The second is plug utilization, which identifies the percentage of time that a vehicle is plugged into a port, regardless of whether or not it is actively charging, relative to the time it is available. The average port in the pilot had a charge utilization of 7% and a plug utilization of 11%. Higher plug utilization is expected given that EVs are often plugged in for longer than they are charging, but large differences in these two rates indicate that there are times when the charger is idle (not charging) but unavailable (vehicle plugged in). Port charge utilization rates varied from 3% at workplace and public sites to 33% at sites used for fleet charging (Table 28). As anticipated, port plug utilization rates were higher than port charge utilization rates, ranging from 5% to 42%. Additional information on utilization rates at the site level is included in Appendix A.

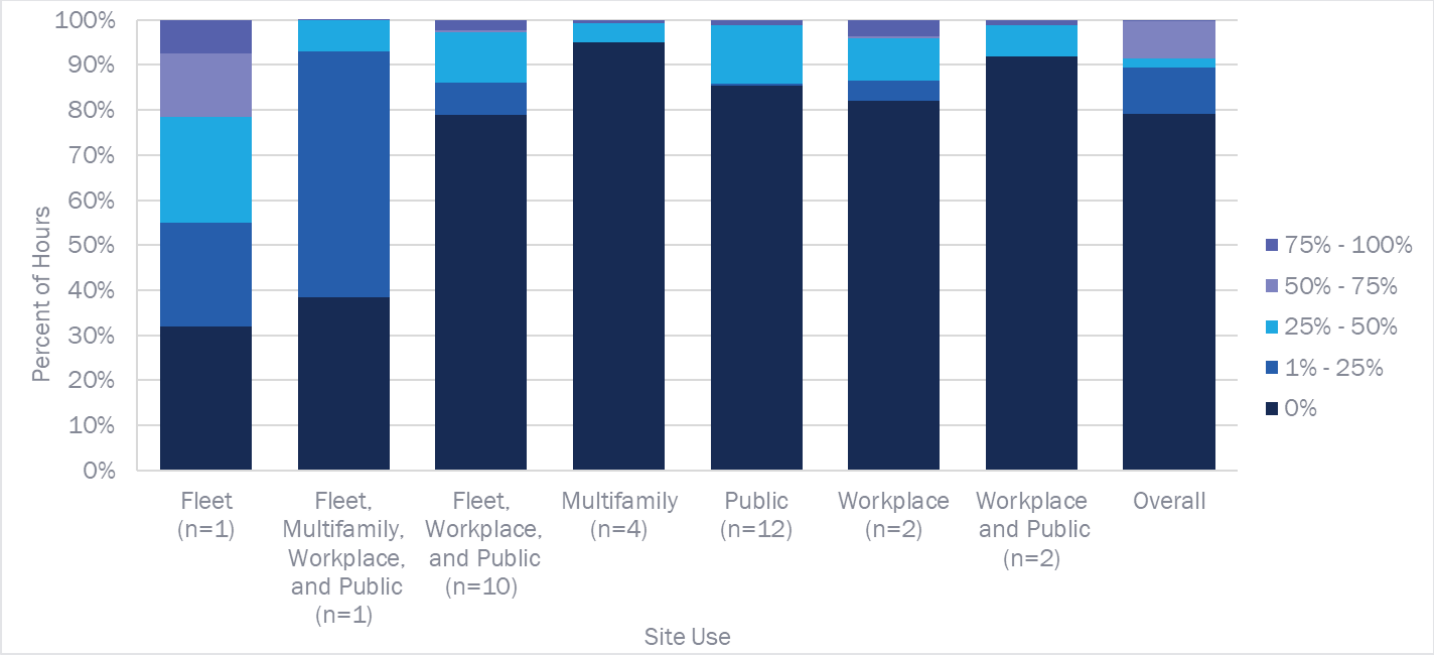
Table 28. Business Charging Rebates Pilot Charging Ports and Plug Utilization Rates

Site Type	Number of Charging Ports	Average Port Charge Utilization	Average Port Plug Utilization
Fleet, Workplace, Public	37	7%	11%
Public	26	4%	5%
Multifamily	8	4%	5%
Fleet, Multifamily, Workplace, Public	18	7%	16%
Workplace	9	6%	9%
Workplace, Public	4	3%	7%
Fleet	4	33%	42%
All	**106**	**7%**	**11%**

Note: Utilization rates are calculated assuming that all chargers are active from their first session through their last session. Utilization rates cannot be calculated for chargers with only one session; these chargers are excluded from this table.

The average site had all chargers available approximately 80% of the time, including overnight hours and weekends. Utilization varied significantly between sites, with some sites never having more than 50% of available ports in use. It was rare that all the chargers at a site were in use at the same time (<0.5% of the average day), suggesting that charging ports are usually available at pilot sites (Figure 39).

Figure 39. Business Charging Rebates Pilot Average Site Utilization, by Site Type



Note: Average daily utilization is calculated by identifying the number of ports charging versus the number of ports available per site per date per hour (across all days and all hours) since a site's first session.

5. FLEET PARTNER PILOT FINDINGS

This section provides findings from interviews and surveys conducted with Fleet Partner Pilot participants and the evaluation team's charging pattern analysis.

5.1 PILOT PARTICIPATION CHARACTERISTICS

Participation in the Fleet Partner Pilot program has been steady since it was launched in July 2021, but most projects have not yet moved on to the Build phase. As of August 2023, 39 participants had completed the Plan phase of the pilot but just seven participants (representing eight charging sites and 42 charging ports) completed the Build phase (Table 29). Ten customers withdrew their applications. Funding for make-ready build-out was fully reserved in early 2023. Staff noted challenges in communicating funding issues to customers, citing the risk of discouraging committed and eligible customers from pursuing participation. Moreover, by the time funding does become available, incentive levels will be reduced, which may cause customers to reconsider moving forward with the Build phase. By 2024, PGE forecasts that up to 75 sites may participate in the pilot.

To date, the pilot has had more participants in the public sector than the private sector. The evaluation team mapped participant sites to census tracts identified by PGE as containing high proportions of underserved customers as defined by HB2165 and found that half (4 of 8) of operational charging sites are located in underserved communities, including 15 chargers and 21 charging ports. Of the underserved community types, three sites were located in low-income areas, two were located in communities adversely harmed by environmental health hazards, and two were located in areas with high proportions of renters.

Table 29. Summary of Participation in the Fleet Partner Pilot Since July 2021

Sector	Withdrawn Sites	Completed Plan Phase Sites	Completed Build Phase	
			Sites	Ports
Public [a]	5	25	6	34
Private[b]	5	14	2	8
Total	**10**	**39**	**8**	**42**

[a] A public organization refers to any government and government-controlled enterprise responsible for the administration of a public service such as a public school district, mass transit agency, wildlife conservancy, water district, or public park and recreation center.

[b] A private organization refers to any for-profit and non-profit enterprise or one of its subsidiaries not owned or controlled by the government such as a sole proprietorship, partnership, small or mid-sized business, large corporation, multinational, trade union, or professional/trade association.

Interviewed and surveyed participants were generally representative of the participant population (Table 30). Among Build phase participants, all reported that the chargers they procured are currently installed and operational. All Build phase interviewees stated that their fleet vehicles are parked on-site, but two mentioned that some of their light-duty fleet vehicles may be taken home by employees with specialized roles within their organization. Among Plan phase participants, all reported that they had received a Fleet Partner Study through the pilot but had not started the installation process. Additionally, all Plan phase interviewees stated that their fleet vehicles are parked on-site, but two mentioned that some of their fleet vehicles may be taken home by employees.

Table 30. Characteristics of Fleet Partner Pilot Participant Interviewees and Survey Respondents (n=17)[a]

Program Phase	Sector	Type of Organization	Current EVs	Approximate Fleet Size	Ports Installed Before Participation
Build	Public	Government Entity	0	90	0
Build	Public	Government Entity	4 EVs, 10 PHEVs	180	4 L2
Build	Public	Government Entity	1 EV	161	2 L2
Build[b]	Public	School District	2 EVs	192	0
Plan	Private	Moving & Storage	0	Unknown	0
Plan	Public	Government Entity	0	Unknown	0
Plan	Public	Government Entity	0	Unknown	0
Plan	Public	Public Transit	10 EVs	Unknown	12 DCFC
Plan	Public	Public Transit	1 EV	Unknown	2 L2
Plan	Private	Food Production	0	Unknown	0
Plan	Public	Parks & Recreation	0	Unknown	0
Plan	Public	Public Transit	10 EVs	Unknown	29 L2
Plan	Private	Interstate Freight Carrier	0	Unknown	0
Withdrew	Private	Transit Bus Contractor	0	845	0
Withdrew	Private	Electrical Contractor	0	355	0
Withdrew	Public	Parks & Recreation	4 EVs, 3 PHEVs	100	0
Withdrew[c]	Private	Auto Dealership	8 EVs	8	4 L2

[a] We conducted in-depth interviews with those in the Build phase of the pilot as well as those who withdrew. For those in the Plan phase of the pilot, online surveys were conducted.

[b] This participant procured both EVs after enrolling in the pilot.

[c] This interviewee mentioned that they already had eight EVs and wanted to know if the pilot could provide incentives for upgrading their existing charging.

For the process-related findings presented below, we combine responses from the 17 participants who participated in interviews and surveys, noting meaningful differences between the participant types (i.e., withdrawn, Plan phase, and Build phase participants) when they exist.

5.2 PILOT AWARENESS, SOURCES OF INFORMATION, AND MOTIVATIONS

Leveraging PGE staff's knowledge and existing relationships with customers to promote the pilot has been effective. Large commercial customers often have existing relationships with PGE's KCMs, local government affairs, and business outreach staff that inform them about PGE offerings via presentations and email outreach. The product team's Salesforce dashboard, which tracks outbound phone calls and follow-up email communications, and annual business review events have also helped to reach customers who might not already have an existing relationship with PGE staff. In addition to maintaining a webpage devoted to the pilot, PGE also has used LinkedIn postings, ride-and-drive events, and tabling at the 2022 Green Transportation Summit and Expo to reach fleet customers. Nine interviewed fleet managers reported learning about the Fleet Partner Pilot from PGE's KCMs (seven mentions) or local government affairs liaisons (two mentions) via meeting or email. Two fleet managers reached out to PGE to learn how they can install make-ready infrastructure for electric school buses. Others learned about the pilot from other municipalities or fleet vehicle vendors (two mentions each).

KCM and business outreach staff need help to stay current on PGE transportation electrification offerings and want to be more involved during the participation process to support their customers. KCMs and business outreach staff would like more information about PGE's transportation electrification offerings. They would also like to be more involved during the Fleet Partner Pilot participation process, including attending their customers' project kickoff meetings. KCMs

and business outreach staff suggested that pilot staff include them in project meetings and provide regular updates about changes to the pilot, so they can provide customers with accurate information and communicate customer needs.

Fleet managers are typically well connected to a network of resources for supporting fleet managers pursuing fleet electrification. Most Pilot participants report utilizing a wide variety of sources to gain information about fleet vehicles or fleet management, including online fleet management resources (12 mentions), industry publications (11 mentions), colleagues (10 mentions), conferences or expos (seven mentions), and auto dealerships (five mentions). Most of these participants receive emails and newsletters from these sources with information that allows them to stay up to date on current trends and upcoming events where they may receive education and training on operating and maintaining fleet vehicles and fleet management systems.

A primary motivation for pilot participation appears to be existing company/organizational goals for fleet electrification. All interviewed fleet managers said that they were seriously considering electrifying their fleets prior to learning about the pilot. Fleet managers mentioned various reasons for electrifying their fleet, including:

- Lowering their fleet operating costs (six mentions)
- Improving air quality (five mentions)
- Encouraging others to adopt EVs (five mentions)
- Inspiring communities to be good stewards of the environment (four mentions)
- Improving their organization's brand image (three mentions)
- Providing an employee perk (one mention)
- Motivations for participating in the Fleet Partner Pilot included:
- Accessing technical assistance (e.g., charger recommendations, comprehensive site assessment, turnkey design, and construction planning) (13 mentions)
- Financial assistance (13 mentions)
- Cost estimates associated with fleet electrification (11 mentions)

5.3 PILOT REQUIREMENTS

Meeting the pilot's new load requirements, energy-use commitments, and easement requirements were challenging for participants. To participate in the pilot, customers are required to add a minimum of 70 kW of new load (usually equivalent to 10 Level 2 ports or one to two DC fast chargers) at the customer site and sign an easement covering PGE-owned infrastructure. One interviewee mentioned that their company was unlikely to meet the minimum 70 kW requirement because that would require them to use more EVs than they had. Four other fleet managers recalled that the energy-use commitment imposed too many restrictions on participation and withdrew from the Pilot because of concerns about meeting this requirement. One interviewee elaborated, saying that after doing their own calculations using their fleet maintenance provider's vehicle management portal and EV fleet vehicle manufacturer data, they found that they could not meet this requirement.

> "When we first, initially, were talking with them, we're kind of like, 'Oh, yeah, maybe we could do a couple of vehicles, a couple SUVs, and then a couple of trucks…' We went from thinking about 50 miles a day as the base, but we found out it was more like 15. So it was one of the things that we're a little concerned about was meeting those kWh requirements. And in the end, having to pay back."

Additionally, three fleet managers mentioned having concerns about the liabilities to the property owners for signing the easement, of which two reported experiencing significant delays due to prolonged legal negotiations between PGE's legal team and their landlords to address those concerns.

5.4 FLEET ELECTRIFICATION TECHNICAL ASSISTANCE

The technical assistance provided by the pilot is appropriate and highly valued by participants, but some participants may need additional support. Most participants reported that the technical assistance they received from PGE (e.g., charger recommendations, comprehensive site assessment, design, and construction planning) was satisfactory, but three participants went on to specify additional technical assistance that they desired. One Plan phase participant mentioned they would like more details on results from the charging, fuel cost, and energy use analysis. For example, more clear explanation of cost and savings assumptions, detailed documentation of sources used to develop assumptions, and additional documentation of emissions reductions. One Build phase participant would have liked additional assistance in determining the optimal number of chargers needed for their fleet. Another Build phase participant stated that they would have liked upfront information about their site's vehicle-to-grid (V2G) capabilities before they moved forward with purchasing V2G-enabled chargers for their site.

PGE's online Total Cost of Ownership (TCO) tool is useful but lacks visibility and advanced features some customers require. The TCO tool is a free fleet planning tool featured on PGE's website that allows fleet managers to calculate the costs and savings associated with electrifying their fleet. Seven out of 17 fleet managers reported using the TCO tool. Those managers who reported using the tool generally found it useful but suggested a need for features that capture demand charges and projected energy usage may impact their monthly bills. Fleet managers that had never used the TCO tool said it was because they were not aware of it (six mentions) or because they were already using a report generated by a similar tool (one mention).

5.5 PROJECT TIMELINE

The initial staffing arrangement for Design Project Managers (DPMs) led to some project delays but was later rectified. The DPM team oversees utility infrastructure designs for every project in the Fleet Partner Pilot during the Build phase. To simplify the Build phase, there was initially only one DPM available in 2022 to work with contractors on final project designs. While the sole DPM performed high-quality work, they became overextended with the influx of new fleet projects, prompting pilot staff to bring in regional DPMs. The addition of regional DPMs (existing PGE staff) has since reduced project delays.

The time it takes to confirm customers' reservations to proceed to the Build phase is adequate for customers. Four Build phase participants reportedly went through a period of waiting to confirm their reservations, all of whom reported that the typical process duration (2 to 3 weeks) was reasonable. One participant reported waiting approximately six months to confirm their reservation and noted that the causes of the delays were a parking lot expansion and a soil study that was done to prepare the site for construction.

Supply chain issues associated with charging infrastructure equipment have increased project timelines and costs. Procuring charging infrastructure equipment has been difficult for the past couple of years due to global supply chain issues. Staff have seen delays in deliveries of transformers of up to 56 weeks and switchgears of up to 65 weeks. All interviewed Build phase participants reported that their completion dates were set back for up to six months due to supply chain issues. These long delays contributed to discrepancies between the estimated and actual costs for a handful of projects. One interviewed inactive fleet manager mentioned that this is essentially a manufacturing problem that the pilot cannot alleviate. Still, PGE staff mentioned that ordering equipment months ahead of the expected delivery date has helped with equipment deliveries and capital planning.

Changes in staffing at customer organizations during the participation process have been an ongoing challenge for fleet electrification and participation. Staff turnover at potential participant organizations can lead to missed funding opportunities or deadlines to submit applications. Two organizations reported that when the time came for them to sign and submit their applications, project leads had been replaced with new staff who were not familiar with the project. One of the organizations reportedly lost a funding opportunity, vital to the feasibility of their project. Pilot staff also find that it becomes increasingly difficult to get project approval when an organization adds more staff to the internal approval process.

5.6 MAKE-READY INCENTIVE LEVELS AND COST ESTIMATES

Phase 1 incentive levels were sufficient for most participants and were not a reason why interviewed inactive fleet managers withdrew from the pilot. As of Augst 2023, most customers found the incentive levels either met (10 mentions) or exceeded (two mentions) their expectations. One Plan phase fleet manager acknowledged that the incentive amount was sufficient at first but was subsequently insufficient to cover the expected 50% of the total cost of construction, due to their existing infrastructure not meeting the requirements to support EV charging. The remaining customers were unable to recall their estimated incentive amounts. Note that incentive levels have since decreased in Phase 2 of the Pilot. Customers who withdrew from the pilot stated that their withdrawal reasons were unrelated to incentives but rather the challenges of meeting the pilot's minimum 70 kW new load requirements or energy-usage commitments discussed above.

Secondary research conducted by the evaluation team suggests that Phase 1 incentive levels align with other utility program offerings. However, making direct comparisons is challenging due to the variety of program and incentive configurations of fleet electrification utility programs. In addition to gathering feedback from Pilot participants on make-ready incentive levels, the team reviewed program designs and incentive levels for 13 different fleet electrification programs offered by utilities across the United States. Given the varied program designs and incentive levels, it was not possible to identify a typical incentive level. However, key program design elements were identified along with a range of incentives for current fleet electrification offerings.[31]

- Eight out of 13 fleet electrification programs offered incentives for both make-ready infrastructure and EVSE projects, with four offering additional incentives for electric fleet vehicle procurement. Additionally, one program provided grant-finding and writing support for EVSE projects.
- Maximum incentive levels for make-ready infrastructure projects varied based on customer charging needs, the type of community that the proposed project would serve, and the type of fleet vehicles that would use the charging infrastructure. Eligible customers enrolled in these programs may receive incentives covering anywhere between 50% to 100% of the upfront costs for make-ready projects.
- EVSE incentive levels varied by utility, ranging from $500 to $4,500 per serviced Level 1 or Level 2 charger and $7,500 to $30,000 for DC fast chargers.

A lack of financial resources to install chargers caused major setbacks to some organizations' fleet electrification plans. Four participants who completed the Fleet Study reported that they were unable to receive funding from PGE. One participant reported having enough funds to install their desired number of chargers without PGE's assistance, but two had to adjust their plans to start small and apply for federal or state grants. One participant who had not moved forward due to lack of funding stated that they had begun looking into grants outside of Oregon. All interviewed Build phase participants stated that they would have proceeded with their projects without the incentives they received from PGE, but half mentioned that they would have had to scale back their projects without the incentives.

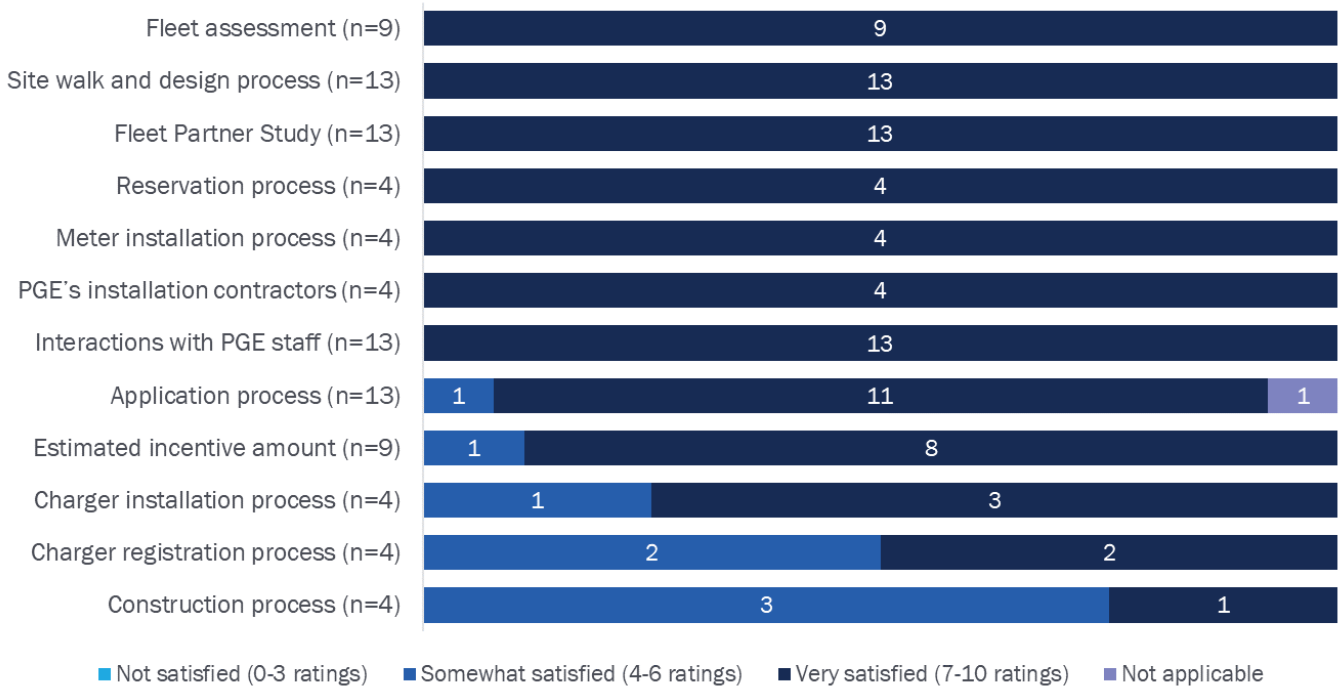
[31] Table 49 in Appendix D provides a summary of the 13 programs reviewed allowing for a comparison of these programs with the Fleet Partner Pilot's participation requirements and incentive levels.

The cost estimates in the preliminary designs were mostly accurate, but there were some inaccuracies due to issues in the predictive model of the TCO tool. Seven Plan and Build phase participants reported that the cost estimates in the preliminary designs met expectations, while the remaining six participants reported that estimated costs for electrifying their fleet were higher than expected. Of the six participants who reported inaccuracies in their cost estimates, five reported that they had used the TCO tool discussed above. While some were unsure of the reasons, one Plan phase participant speculated that the TCO tool did not factor in all the potential factors for accurately determining costs and commitments discussed above. Others attributed the deviations to the impacts of inflation on the cost of equipment (1 mention) and added labor costs incurred due to design changes made by PGE engineers (1 mention).

5.7 PILOT PARTICIPANT SATISFACTION

Participants reported high levels of satisfaction with the Pilot. All interviewed participants indicated they were very satisfied with most elements of the Fleet Partner Pilot (Figure 40). Participants were somewhat less satisfied with the charger registration and make-ready construction process. Two Build phase participants reported that completing the make-ready construction process was straightforward, but one went on to mention that inconsistent notices from their construction companies about construction visits led to a poor make-ready construction experience. The other participants reported experiencing some unexpected delays. One stated that their construction start date was set back due to an additional easement they needed to complete a line extension that would pass through a part of the property that a neighboring organization privately owned. The other participant recalled the permitting process being delayed due to safety examinations of the underground lines that were to be connected to the charging equipment.

Figure 40. Participant Satisfaction with Fleet Partner Pilot[a]



[a] Inactive participants were not asked to rate their satisfaction with the pilot and are not included in the above figure. Items with 13 responses were asked of both Plan and Build phase participants, items with 9 responses were asked of only Plan phase participants, items with 4 responses were only asked of Build phase participants. Note one participant did not have direct experience with the application process and was unable to provide a rating.

5.8 INTEREST IN UTILITY MANAGED CHARGING

Most Pilot participants are interested in utility managed charging but need to learn more before signing up. Nine participants were interested in participating in a managed charging program. Most of these participants stated that while they have no specific concerns, they would like more information to fully understand how such a program would impact their organization. One Build phase participant stated that their only concern would be how the programs would impact their capacity to handle emergency situations such as extreme weather events or medical situations in which people would need to be transported reliably and quickly. Two Build phase participants mentioned that they had already adopted building energy management systems and that they are comfortable with PGE remotely managing when they charge.

5.9 FLEET CHARGING PATTERN ANALYSIS

The charging pattern analysis for the Fleet Partner Pilot is limited to the sites and chargers that had available charging data by the end of August 2023. We received charging data for three out of seven participants comprising 17 of 36 chargers installed through the pilot. Two of the sites for which we received data were missing data for one or more chargers. Below is a summary of available data relative to pilot participants in Table 31. Only public/government customers had available data. Charging data evaluated are only from Level 2 chargers as no DCFCs had charging data available. Additional information on charging data availability is included in Appendix C.

Table 31. Fleet Partner Pilot Participation Overview

Customer	Customer Type	Number of Sites	Number of Chargers	Chargers with Data
200001	Private	1	1	No data – No vehicles to charge
200002	Public	1	3	No data – Chargers not installed until August 2023
200008	Public	1	6	6
200009	Public	1	10	9
200051	Private	1	6	No data – Missing data from the charging vendor
200449	Public	2	6	No data– Chargers not installed until August 2023
201361	Public	1	4	2

Across the 17 chargers, there were 245 charging sessions during the study period. Most sessions occurred at Site 100011 (199), with Site 102190 recording the lowest number of sessions at 13. Overall, average charging and session duration vary greatly between sites (Table 32). The average electricity dispensed per session was 8.49 kWh per session. Additional details on variations between chargers at each site can be found in Appendix C.

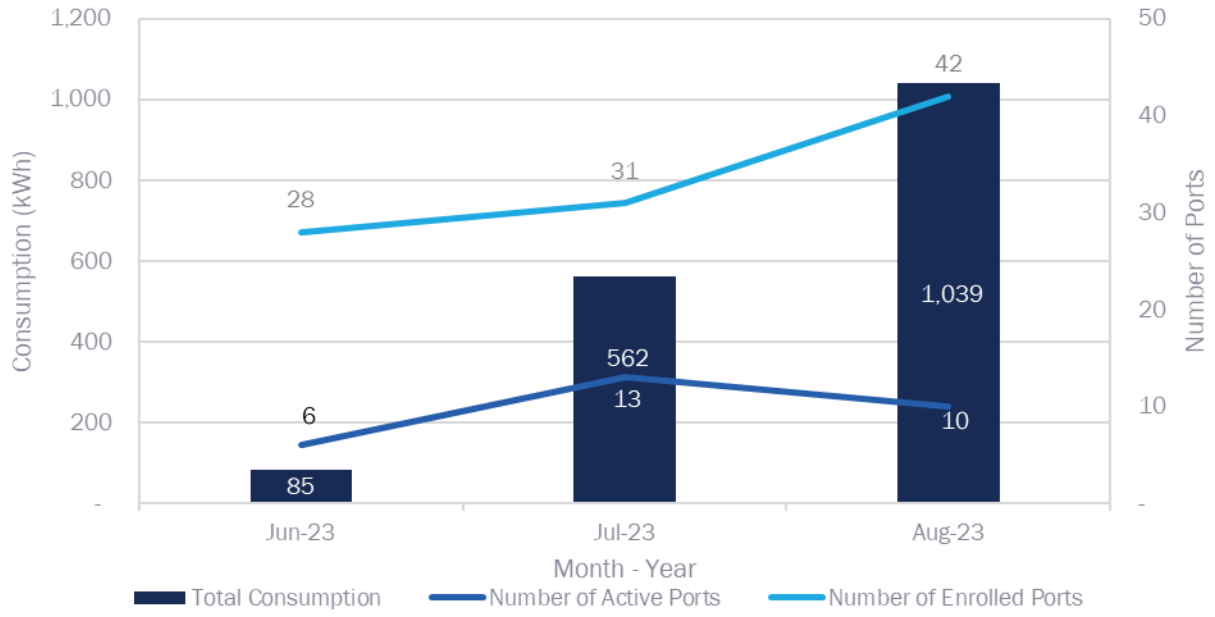
Table 32. Fleet Partner Pilot Charging Sessions Summaries by Site

Site	Site Use	Number of Charger Ports	Number of Sessions	First Charge	Last Charge	Average Charge Duration (hrs.)	Average Session Duration (hrs.)	Average Electricity Dispensed (kWh)
100011	Fleet	6	199	6/29/2023	8/31/2023	1.94	8.63	6.38
100014	Fleet, workplace, and public	9	33	6/2/2023	8/26/2023	2.47	2.98	14.66
102190	Fleet and workplace	2	13	7/10/2023	8/30/2023	4.04	6.32	25.07
Total	**All**	**17**	**245**	**6/2/2023**	**8/31/2023**	**2.13**	**7.74**	**8.49**

5.9.1 CONSUMPTION AND CHARGING PATTERNS

Aggregated monthly energy consumption increased from June 2023 to August 2023, reaching a peak of 1,039 kWh in August. Given the short period Fleet Partner sites have been active and the small number of chargers with data, in-depth analysis of timeline trends and patterns is limited. Figure 41 shows the total consumption per month across all sites with data as well as the number of charging ports with data. There is an increase in the number of chargers with data between June and July 2023 but a decrease between July and August 2023. This is not due to the chargers being retired or removed from the pilot but rather because no sessions were recorded in August for some of the chargers (this could be due to missing data, the charger being offline, or no sessions occurring). The increase in consumption in August 2023 is therefore likely due to the increased use of existing chargers.

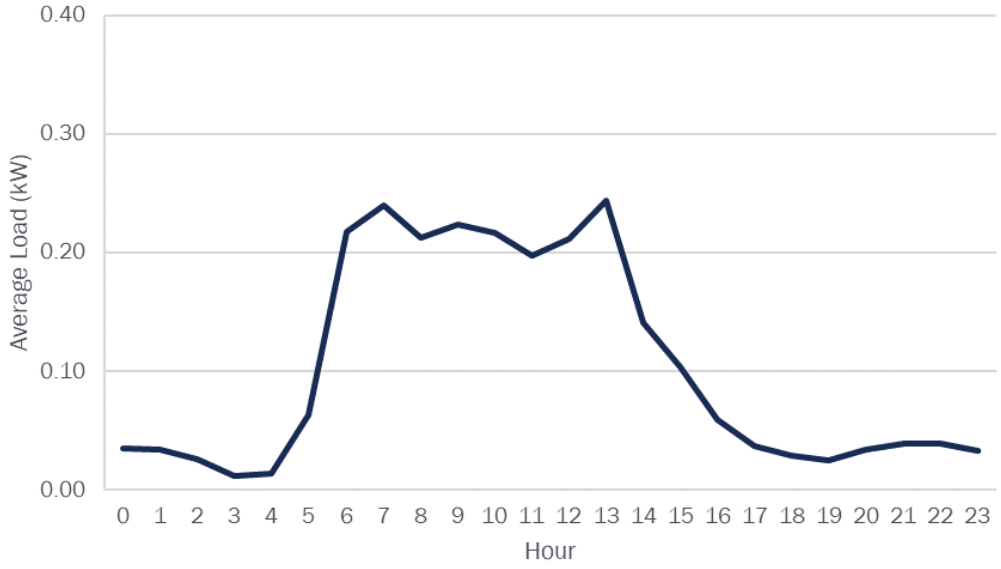
Figure 41. Fleet Partner Pilot Monthly Energy Consumption



Note: A port is considered active between its first and last recorded charging session. A port is considered enrolled based on its install and retirement date.

The average charging load for Fleet Partner sites combined is plotted in Figure 42. The average daily load profile starts to ramp up around 6:00 a.m. and the load decreases after 1:00 p.m. Load curves for the individual sites, and variations between day types, are in Appendix C.

Figure 42. Fleet Partner Pilot Average Load Curve

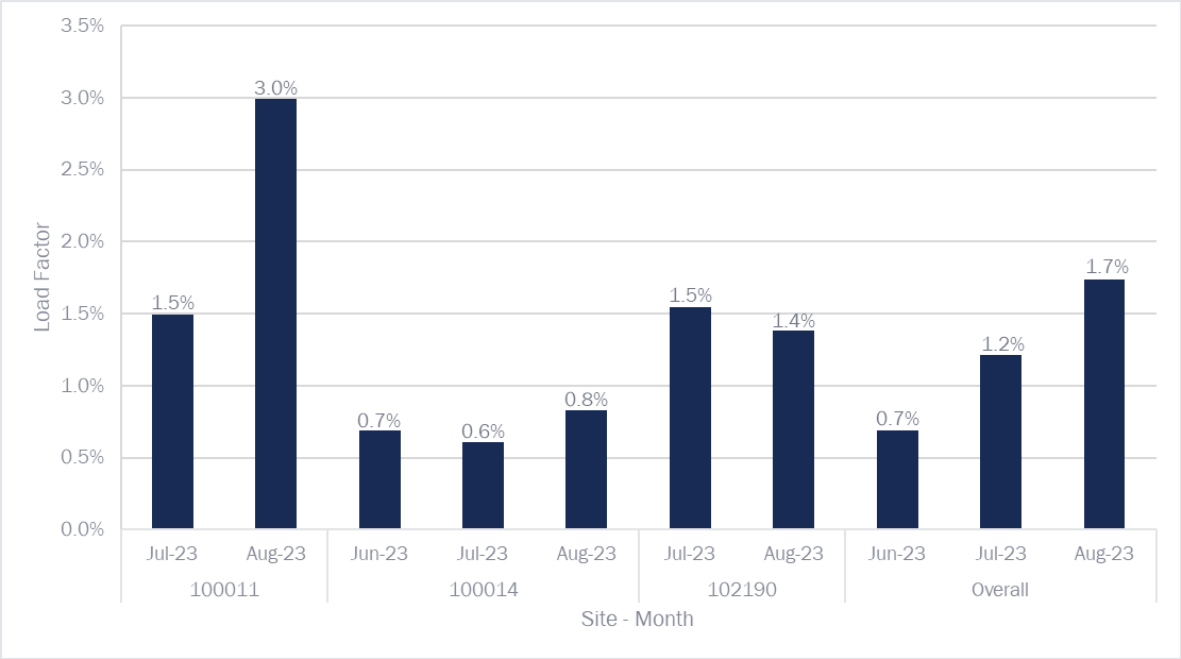


5.9.2 PEAK IMPACT

No Fleet Partner Pilot sites with available data were enrolled on a TOU rate at the time of the 2023 evaluation, therefore, TOU rate exploration was excluded from this analysis. Additional analysis will be conducted in 2024 when additional sites come online.

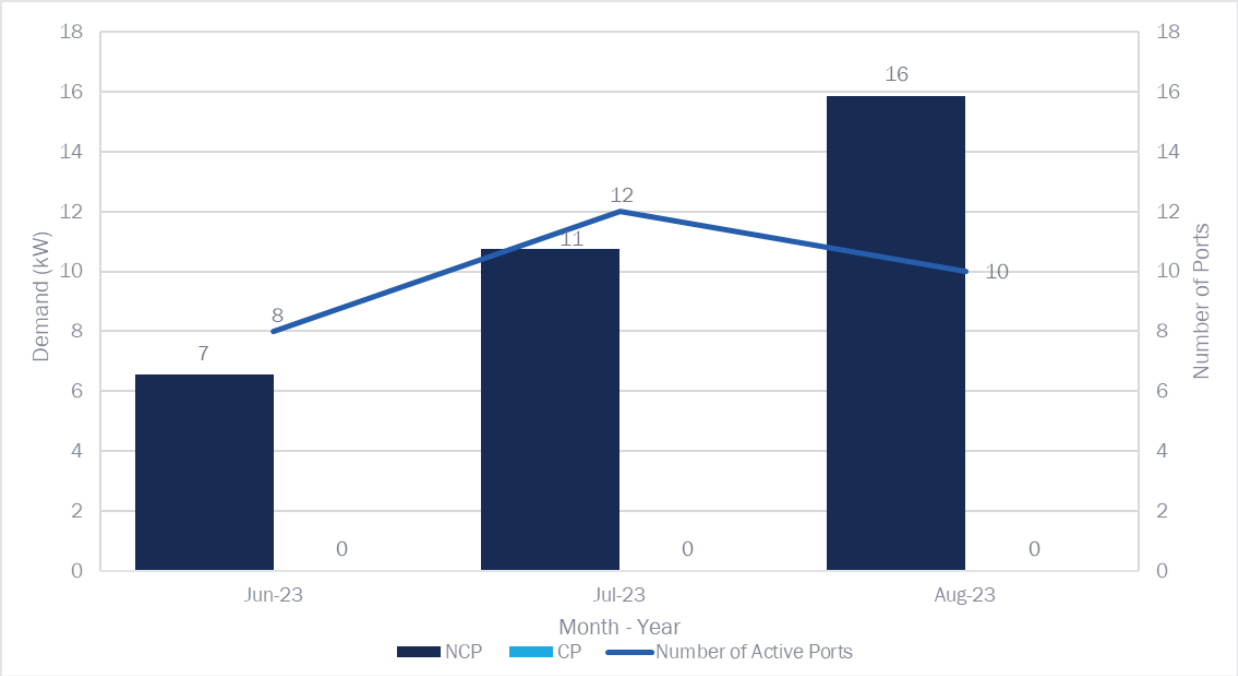
Throughout the study period, the load factor of charging across all sites increased but remained relatively low. Load factors for each site and, overall, for all months are included in Figure 43. Low load factors indicate that the average consumption per site is a very small percentage of the maximum consumption per site, meaning that there are periods of relatively high usage but there is a relatively low rate of utilization. The increase in load factors seen between months, overall, can likely be attributed to the increased usage of existing chargers relative to the maximum demand. This is largely driven by the increase in consumption of Site 100011 relative to the maximum consumption of that site. Given the limitations in the number of activated sites and timeframe, additional data is needed to establish more conclusive trends.

Figure 43. Fleet Partner Pilot Load Factors



Throughout the study period, the NCP load of Fleet Partner sites increased. The NCP increases from 7 kW (8 active charging ports) to a peak of 16 kW (10 active charging ports) as additional sites and ports are activated (Figure 44). In addition to the non-coincident peak, the evaluation team also investigated the system coincident peak (CP), which represents the charging load peak contribution during PGE's system peak hours. Our analysis indicates that charging peak load is not frequently coincident with PGE system peak load.

Figure 44. Fleet Partner Pilot Coincident and Non-Coincident Peak Load



5.9.3 CHARGER UTILIZATION

Port charging and plug utilization rates varied greatly between Fleet Partner sites. Port charge utilization rates varied from 2% to almost 4% across sites (Table 33). Port plug port utilization rates ranged from 2% to 20%. At fleet Site 100011, plug utilization was over three times higher than charge utilization, which is expected as fleet EVs are often plugged in for longer than they are charged.

Table 33. Fleet Partner Pilot Charger and Plug Utilization

Site	Number of Charger Ports	Average Port Charge Utilization	Average Port Plug Utilization
100011	6	4%	20%
100014	6	2%	2%
102190	2	2%	3%
Total	**14**	**2%**	**8%**

Note: Utilization rates are calculated assuming that all chargers are active from their first session through their last session. Utilization rates cannot be calculated for chargers with only one session, and so any such chargers are excluded from the average.

APPENDIX A. RESIDENTIAL CHARGING PILOT: IMPACT ANALYSIS METHODS AND CHARGING PATTERNS

APPENDIX A-I. DATA CLEANING AND PREPARATION

APPENDIX A-I.I. PARTICIPANT DATA

The team relied on participant data extracts provided by PGE. Data we received included vehicle/charger enrollment and unenrollment records starting in 2020. Each record contained associated customer information, enrollment dates, unenrollment dates (where applicable), EV and charger information, and group designation, among other data fields. As part of the data cleaning process, we reconciled participant charger and EV counts and IDs, reviewed, and eliminated duplicate records, and addressed gaps, missing, and unreasonable values, where possible and feasible. We transformed the data, so it was at the vehicle level for evPulse participants and the charger level for EVSE participants. Finally, we verified the accuracy of the customer program enrollment date, merged in TOD and PTR enrollment information, and identified EV types using the available EV make information and post-event survey information, where applicable.

APPENDIX A-I.II. CHARGING DATA

The EVSE telemetry data contained charger-level hourly interval load data. As part of the EVSE data cleaning, we reviewed the data for duplicate records, identified missing records and imputed data when possible, corrected outlier records, and removed participant days with insufficient data.[32] Additionally, the charging interval data provided for EVSE participants in the Winter 2022/2023 Event Season was provided in Watts rather than kW, so an additional step was added to convert the data to kW. Finally, the Group B December file was provided with all records recorded as negative, which we also adjusted.

The evPulse vehicle telemetry data contained vehicle-level 15-minute interval load data. As part of the data cleaning, we reviewed the data for duplicate records, imputed missing records, aggregated the data to an hourly level, and fixed outlier records. The data was similarly scrutinized for participant days with less than 24 hours of interval data.

Table 34 summarizes cleaning steps, by season, made to each charging data source as part of the data preparation and cleaning process. After initial cleaning, we filtered the data to include relevant participants and days, per season. PTR days were excluded from the analysis. In cases of a charger changeover, interval data was combined across the two chargers, however, in cases of a vehicle changeover the interval data was kept separate. This led to a few discrepancies between the participation data and the impact data. For equivalency, modeling, and opt-out analysis purposes, we required that participants have data for 75% of a season's days. We dropped records with insufficient data across the relevant event season.

[32] Imputations were conduct for missing data. If an entire hour was missing, 0 consumption was imputed for that hour. If an interval within an hour was missing, then the average of the other observations in that hour were used for imputation.

Table 34. Residential Charging Pilot Charging Data Cleaning Steps

Drop Reason	Winter 2021/2022		Summer 2022		Winter 2022/2023	
	Vehicles/Chargers	Observations	Vehicles/Chargers	Observations	Vehicles/Chargers	Observations
EVSE						
Initial Count	587	1,961,699	977	3,401,286	1,270	4,685,677
Drop Exact Duplicates	587	1,790,510	977	3,277,593	1,270	4,685,677
Fix Imperfect Duplicates	587	1,788,147	977	3,277,574	1,270	4,685,677
Imputation	587	1,788,710	977	3,285,614	1,270	4,689,205
Outlier Fix	587	1,788,710	977	3,285,614	1,270	4,689,205
<24 Hours of interval data	587	1,783,536	977	3,274,560	1,270	4,683,000
evPulse						
Initial Count	516	351,188	498	846,348	1,312	1,282,369
Drop Exact Duplicates	516	351,188	498	729,286	1,312	1,282,369
Fix Imperfect Duplicates	516	351,188	498	729,286	1,312	1,282,369
Imputation	516	3,662,096	498	7,924,622	1,312	14,785,289
Roll up to an hour	516	936,790	498	2,021,914	1,312	3,767,933
Outlier Fix	516	936,790	498	2,021,914	1,283	3,745,584
<24 Hours of interval data	510	926,616	486	2,012,616	1,283	3,745,584

The available data had several limitations. The EVSE charger telemetry data was missing for Group A for October 2021. As a result, we excluded October 2021 from the impact analysis. The initial counts in the above table reflect the exclusion of October. Additionally, we found other missing data across groups, usually the last few days or hours of a month. We determined that the small amount of missing data would not greatly impact results and used all available data for each period when modeling savings and charging patterns.

APPENDIX A-II. EVENT DEMAND IMPACTS

Our impact analysis included an equivalency analysis and estimating the impact of the pilot on EV charging load during each group's event period. Below, we outline analytical activities and key results that were a part of the analysis.

APPENDIX A-II.I. EQUIVALENCY ANALYSIS

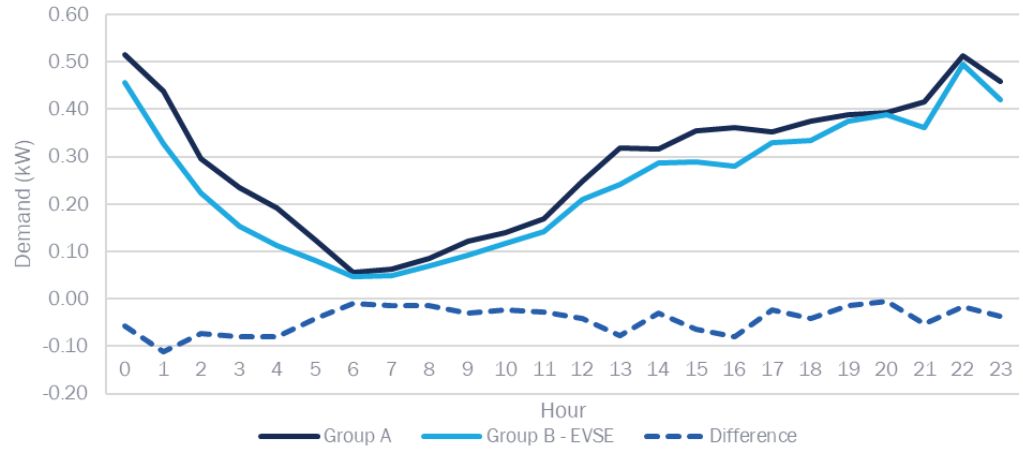
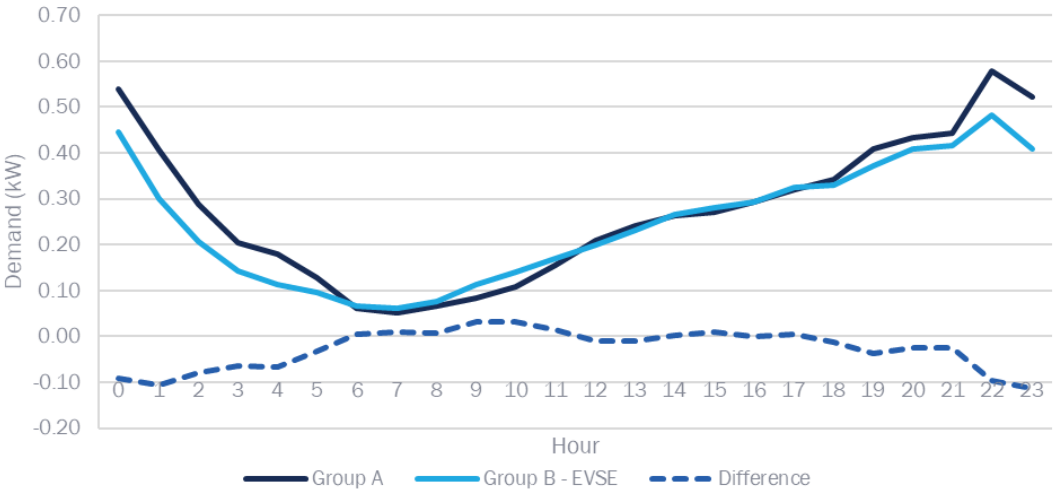
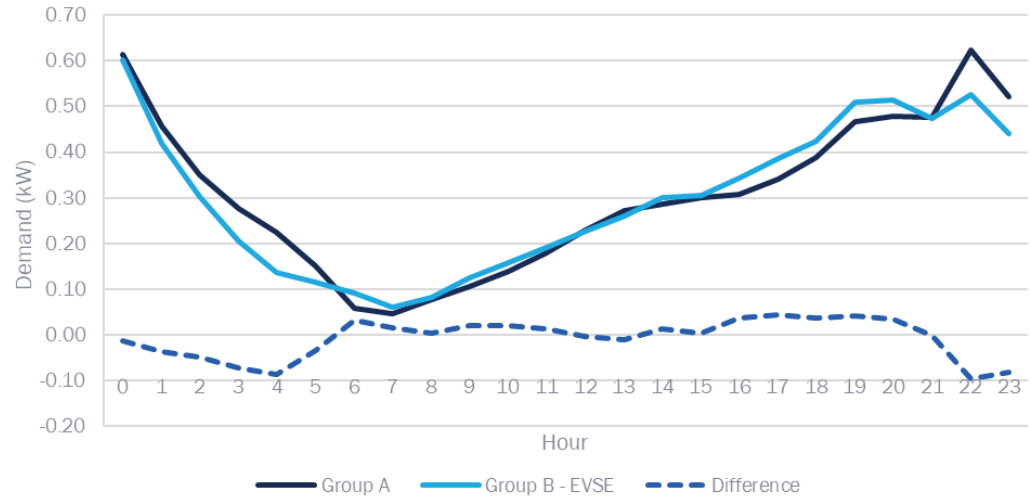
To validate the fidelity of the pseudo-experimental design, the team conducted an equivalency analysis. Due to the pilot design, there are no weekdays (non-holidays) in the event season where charging was not curtailed during event hours for treatment groups. Additionally, there was minimal pre-period data available for participants. Therefore, the team is limited by the lack of untreated days in which to conduct an equivalency analysis between the control group and the treatment groups.

Due to this lack of data, the team used weekend load shapes to evaluate equivalency. The use of weekends is an imperfect approach for several reasons. First, weekend energy use may differ between the treatment and control groups due to the pilot, as events called among treatment customers during the week may impact their charging behavior on the weekend, even though there are no curtailment events on the weekend. Second, weekend charging

behavior may be different from weekday charging for many customers, which means that we assessed equivalency using days that may be different from event days. This reduces our confidence that the differences in treatment and control group charging behavior on event days are due to the pilot alone.

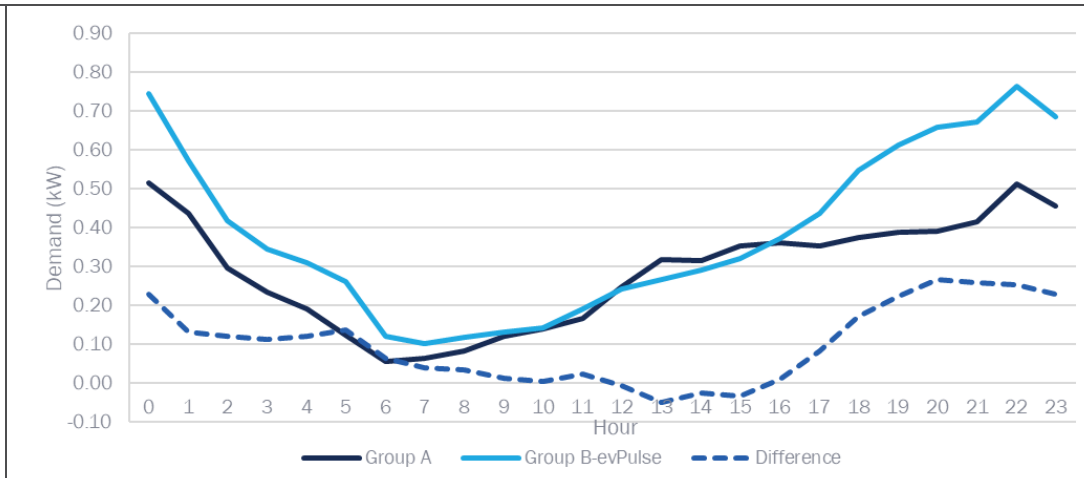
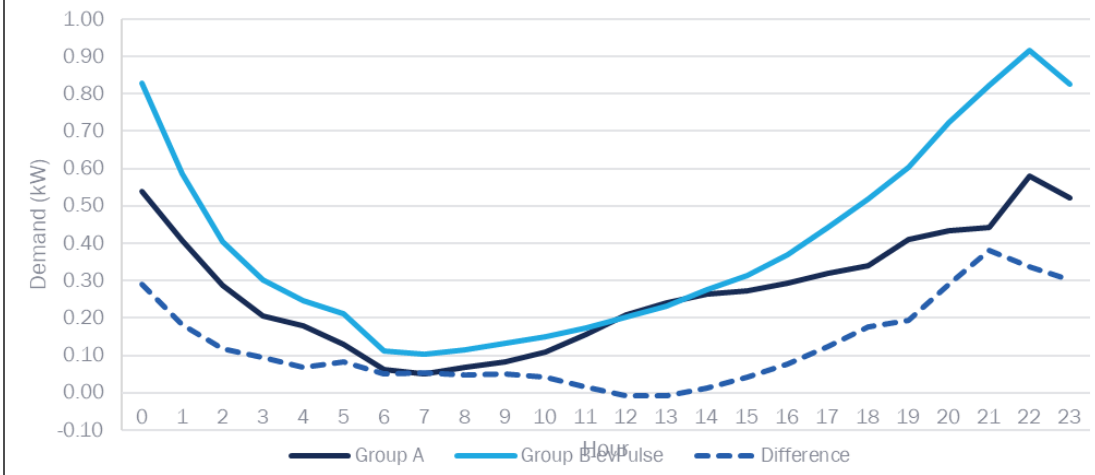
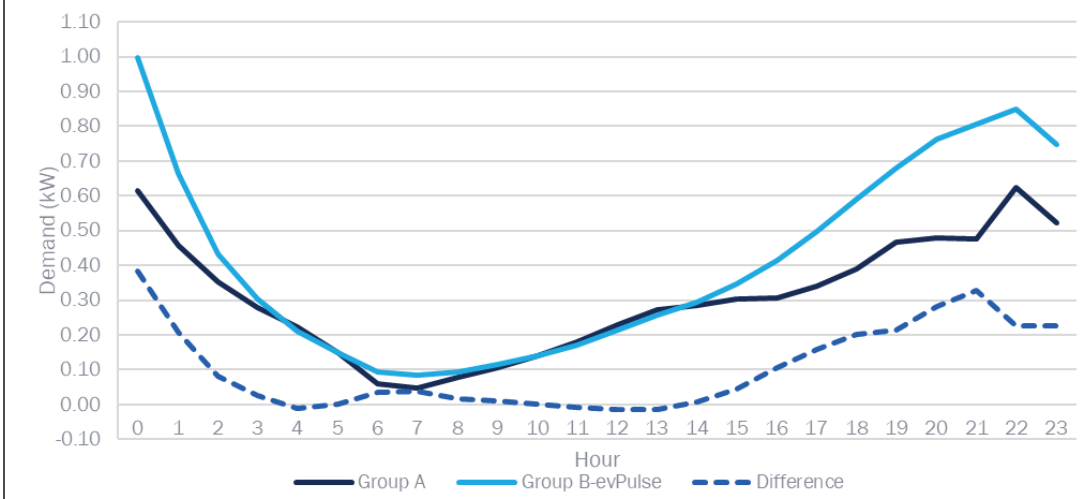
Weekend and holiday load shapes illustrate charging patterns without load control for the treatment groups compared to the control group (Figure 45). The difference between the groups is also graphed as the dashed line. The weekend/holiday load shapes are an imperfect metric for equivalency, but they do provide some indication of charging pattern. In general, Group B and Group A weekend/holiday load shapes are relatively similar in trend and magnitude. This is also true for Group C; Group C has a larger separation in the morning hours which is likely due to the spillover of weekday charging or charging schedules. For example, on Friday evening when a vehicle is curtailed from 10-12, this charging may be completed on Saturday morning. Alternatively, participants may program chargers for event purposes and do so for seven days a week despite the events only being in effect on weekdays. This does not occur for Group A, since this group does not have charging curtailed. After the morning hours, the control and treatment Group C are very similar. We see a much larger separation in charging load between Group B evPulse and Group A in magnitude.

Figure 45. Weekend and Holiday Load Shape Equivalency Analysis between Group A and Group B (EVSE) by Season

Group B EVSE Winter 2021/2022	
Group B EVSE Summer 2022	
Group B EVSE Winter 2022/2023	

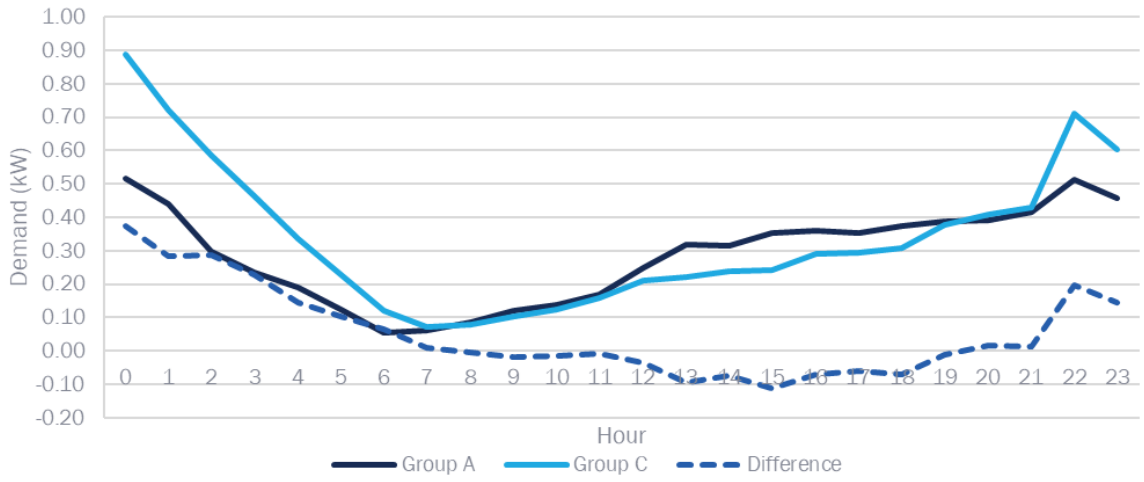
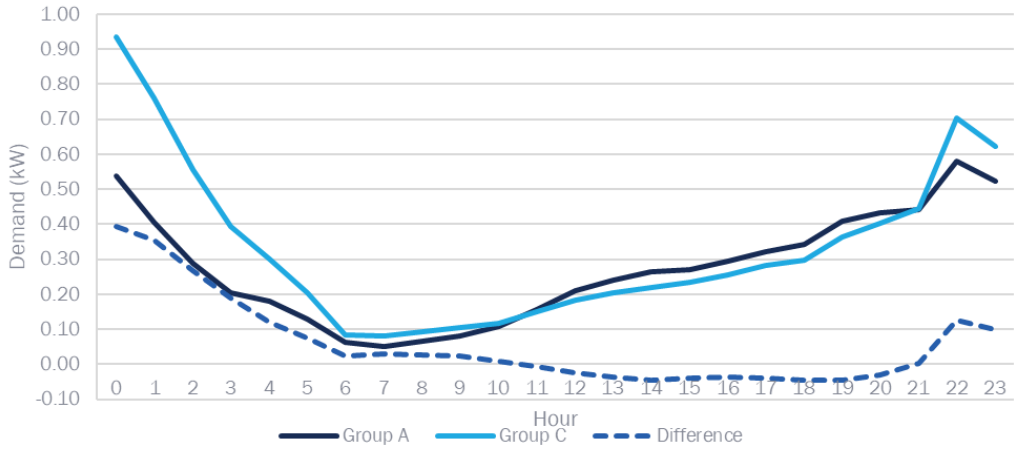
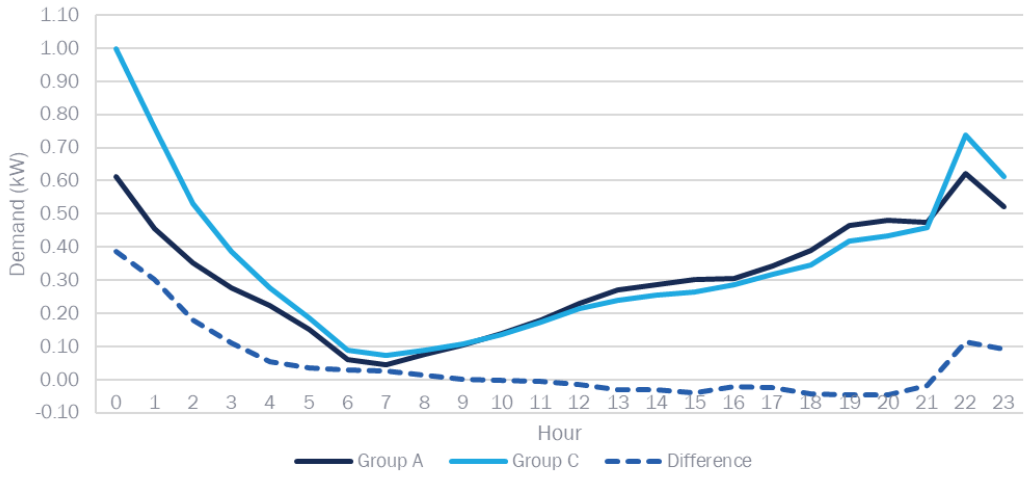
Note: The y-axis varies between load shape graphs. Graphs exclude evPulse away charging and PTR event days.

Figure 46. Weekend and Holiday Load Shape Equivalency Analysis between Group A and Group B (evPulse) by Season

Group B evPulse Winter 2021/2022	
Group B evPulse Summer 2022	
Group B evPulse Winter 2022/2023	

Note: The y-axis varies between load shape graphs. Graphs exclude evPulse away charging and PTR event days.

Figure 47. Weekend and Holiday Load Shape Equivalency Analysis between Group A and Group C by Season

Group C Winter 2021/2022	
Group C Summer 2022	
Group C 2022/2023	

Note: The y-axis varies between load shape graphs. Graphs exclude evPulse away charging and PTR event days.

There are multiple factors that may be contributing to the inequivalences between Group B evPulse and Group A. Vehicles in Group B evPulse have a higher average daily EV charging consumption and hourly demand compared to the control group. Table 35 shows average consumption and demand per vehicle/charger per day (kWh) and per hour (kW).

Group B evPulse has 25% to 35% higher per vehicle/charger average daily consumption and hourly demand compared to the control group across all seasons.

Table 35. Average Consumption and Demand per Vehicle/Charger, by Season evPulse and Group A

Group/ Season	Average Consumption per Vehicle/Charger per Day (kWh)	Average Consumption per Vehicle/Charger per Hour (kW)
Winter 2021/2022		
Group A	6.94	0.29
Group B (evPulse)	8.76	0.37
Summer 2022		
Group A	6.47	0.27
Group B (evPulse)	8.71	0.36
Winter 2022/2023		
Group A	7.29	0.30
Group B (evPulse)	9.34	0.39

Note: Summaries exclude evPulse away charging and PTR event days.

In addition, the team explored participant characteristics that may impact charging across the groups. Key characteristics include enrollment in a TOD rate across all groups, and specific to EVSE participants, the number of EVs per home, and the EV type. We anticipate that these characteristics may impact a customer's charging load.

Another key difference between the two groups is the unit of observation. The unit of observation for Group A is the charger, while the unit of observation for Group B evPulse is the EV itself, therefore it is not a like-to-like comparison.

Another notable difference between the groups, and potentially the largest piece of discrepancy, is the composition of EV types; evPulse only includes Tesla vehicles, which are all BEVs, while Group A also includes PHEV vehicles. However, even controlling for EV type in Group A, evPulse had higher usage values relative to Group A BEVs (breakdowns are included in the charging pattern analysis section of the report).

Another area where the evPulse channel differs from the EVSE channel is the control strategy used. Participants enrolled in evPulse are enrolled in a dynamic optimization program. WeaveGrid shared that they encourage participants to have their car plugged in as much as possible and encourages them not to set a schedule on their charger (this could interfere with the optimization). Additionally, evPulse does not throttle charging as a part of optimization. The start and stops of charging are optimized but when the vehicle is charging, it is at the full capacity of the charger. The optimized schedule of charging is developed based on three attributes:

- Driver needs and preferences – this is the first and most influential attribute and is driven by the charge-ready time selected by the participant.
- TOU and TOD rate – the driver's electricity cost is the next most important factor in determining optimized charging times.
- PGE DR event window - is the third factor considered when optimizing charging.

Optimization occurs whenever a vehicle is plugged in at home (aside from in the case of technological issues), which includes weekends.

The evaluation team deemed that the control group and treatment Group B (EVSE) and Group C were equivalent enough to model impacts but that the evPulse participants did not have required representation in the control group to be considered equivalent.

APPENDIX A-II.II. LOAD IMPACTS: SIMPLE DIFFERENCES

As a beginning step in the analysis, the team compared the hourly load values on the average event day of the control group with the treatment groups to roughly estimate the kW savings of the average event. For each treatment group (i.e., Groups B-EVSE, B-evPulse, and C), the team estimated hourly kW demand impacts on a per-vehicle level for the evPulse participants and a per-charger level for the EVSE participants on the average event day. To determine the demand impacts, the team subtracted the mean charging demand (kW) during the event hours of the control group (Group A) from the treatment groups. Away charging for evPulse participants was excluded from this analysis. Separate analyses were conducted for each event season. This analysis does not adequately control for the time-invariant characteristics of participants, as our modeling impact analysis does.

Table 36 presents the impact results leveraging a simple difference approach compared to the modeled approach. The straight difference approach is relatively in line with the modeled results. Notably, the model generates separate outputs for TOD and non-TOD participants in Group C for the Winter 2022/2023 Event Season; these groups are not separated when calculating straight differences. To make these approaches comparable, the team applies a weighted average to the modeling approach for the Winter 2022/2023 Event Season to generate an overall impact for Group C. We include evPulse in this straight difference exploration despite removing them from modeled results.

Table 36. Average Performance by Event Season

Season	Group	Straight Difference: Average Hourly Demand Impact per Charger/Vehicle (kW)	Modeled: Average Hourly Demand Impact per Charger/Vehicle (kW)
Winter 2021/2022	Group B (EVSE)	0.29	0.27
	Group B (evPulse)	0.23	
	Group C (EVSE)	0.50	0.48
Summer 2022	Group B (EVSE)	0.27	0.27
	Group B (evPulse)	0.22	
	Group C (EVSE)	0.56	0.51
Winter 2022/2023	Group B (EVSE)	0.24	0.34
	Group B (evPulse)	0.25	
	Group C (EVSE)	0.55	0.62*

Note: Excludes evPulse away charging and PTR event days.
* Weighted average of Group C and Group C TOD

APPENDIX A-II.III. LOAD IMPACTS: FIXED EFFECTS MODEL

We used fixed effects linear regression modeling to develop event season demand impacts, with the fixed effect set at the charger/vehicle level. We incorporated fixed effects terms to control for time-invariable, unobservable factors affecting demand (i.e., factors that do not change over the study period, such as the power draw of the vehicle) without measuring those factors explicitly in the models. The model estimated the hourly kW demand impacts on a per-vehicle/EVSE level. EVSEs assigned as control were used to construct baseline or counterfactual load. Since events were called daily on weekdays during each season, event impacts were not calculated per event, but in aggregate for each event season across all events.

Notably, we did not model evPulse participants due to the lack of a representative control group. Event impacts were calculated as the mean difference between the modeled (predicted) baseline kW and the modeled (predicted) event kW over the event period. Despite low r-squared values, the modeled results are reasonable and statistically significant,

with similar savings values to the average difference-in-difference results we calculated. The low r-squared values may be due to the variability and high frequency of zeros in the interval data.

As is standard practice for impact analyses, we tested several different model specifications before selecting the best model. We also tested several models controlling for EV type. See below for model specifications and model fit outputs chosen by season and group.

Additionally, we estimated TOD event impacts for Group C Winter 2022/2023 since a large percentage of the Group C participations in the Winter 2022/2023 Event Season were also on a TOD rate. The team does not report TOD event impacts for Winter 2021/2022 or Summer 2022, however, because the model results showed that impacts were not statistically significant during event hours. This is likely due to the low number of TOD customers in Group A for Winter 2021/2022 and Summer 2022 which, after cleaning, did not allow the model to fully capture the consumption variation for these vehicles.

We calculated the average event impact by multiplying the per-charger per event modeled impacts by the number of chargers enrolled as of the end of the event season per group. This value does not represent realized event-season demand savings for each event. There is rolling enrollment in the pilot and not all participants who are enrolled at the end of the event season were enrolled for every event day of that season.

Model Specification

Equation 1 shows the model specification used to develop event hour impacts for EVSE vehicles in Group B for the Winter 2021/2022, Summer 2022, and Winter 2022/2023 Event Seasons and Group C for the Winter 2021/2022 and Summer 2022 Event Seasons. The fixed effect was specified at the EVSE vehicle level.

Equation 1. Residential Charging Pilot Event Hour Impact Model Specification for Group B All Event Seasons and Group C Winter 2021/2022 and Summer 2022 Event Seasons

$$kW_{it} = \alpha_i + \sum_{t=Event\ Start}^{Event\ End} \beta_{Treatment \cdot Event\ Hour} \cdot Treatment_i \cdot Event\ Hour_t + \sum_{t=Deferred\ Charging\ Start}^{Deferred\ Charging\ End} \beta_{Treatment \cdot Deferred\ Charging} \cdot Treatment_i \cdot Deferred\ Charging\ Hour_t + \sum_{t=0}^{23} \beta_{Hour_t} \cdot \mathrm{Hour_t} + \varepsilon_{it}$$

Where:

α_i= EVSE vehicle-specific intercept
$Treatment_i$ = Indicator variable for treatment customers for EVSE vehicle *i*
$Deferred\ Charging\ Hour_t$= Indicator variable for deferred charging after demand response event (5 hours after the event) for time-period *t*
$Event\ Hour_t$ = Indicator variable for Group B event hours (3 hours) for time-period *t*
$Hour_t$= Set of 23 indicator variables for hours of the day
ε_{it}= Error term

Equation 2 shows the model specification used to develop event hour impacts for EVSE vehicles in Group C for the Winter 2022/2023 Event Season. The fixed effect was specified at the EVSE vehicle level.

Equation 2. Residential Charging Pilot Group C Event Hour Impact Model Specification for Winter 2022/2023 Event Season

$$kW_{it} = \alpha_i + \sum_{t=Event\ Start}^{Event\ End} \beta_{Treatment \cdot Event\ Hour} \cdot Treatment_i \cdot Event\ Hour_t + \sum_{t=Event\ Start}^{Event\ End} \beta_{Treatment \cdot Event\ Hour \cdot TOD} \cdot Treatment_i \cdot Event\ Hour_t \cdot TOD_i + \sum_{t=Event\ Start}^{Event\ End} \beta_{Event\ Hour \cdot TOD} \cdot Event\ Hour_t \cdot TOD_i + \sum_{t=Deferred\ Charging\ Start}^{Deferred\ Charging\ End} \beta_{Treatment \cdot Deferred\ Charging} \cdot Treatment_i \cdot Deferred\ Charging\ Hour_t + \sum_{t=Deferred\ Charging\ Start}^{Deferred\ Charging\ End} \beta_{Treatment \cdot Deferred\ Charging \cdot TOD} \cdot Treatment_i \cdot Deferred\ Charging\ Hour_t \cdot TOD_i + \sum_{t=0}^{23} \beta_{Hour_t} \cdot Hour_t + \varepsilon_{it}$$

Where:

α_i= EVSE vehicle-specific intercept
$Treatment_i$ = Indicator variable for treatment customers for EVSE vehicle *i*
$Deferred\ Charging\ Hour_t$= Indicator variable for deferred charging after demand response event (5 hours after the event) for time-period *t*
$Event\ Hour_t$ = Indicator variable for Group C event hours (2 hours) for time-period *t*
$Hour_t$= Set of 23 indicator variables for hours of the day
TOD_i= Indicator variable for TOD customers for EVSE vehicle *i*
ε_{it}= Error term

Model Outputs

Table 37 summarizes load impacts by season for each hour of the event for Group B (three event hours).

Table 37. Residential Charging Pilot Group B Summary of Hourly Per Season Load Impacts

Season	Hour	Modeled Baseline Load (kW)	Demand Impact (kW)	% Demand Impact	Standard Error	Lower Bound (90%)	Upper Bound (90%)
Winter 2021/2022	17	0.34	0.25	74%	0.04	0.18	0.32
	18	0.39	0.29	75%	0.05	0.20	0.37
	19	0.41	0.28	68%	0.06	0.17	0.39
Summer 2022	17	0.29	0.23	82%	0.03	0.18	0.29
	18	0.32	0.27	85%	0.03	0.22	0.33
	19	0.36	0.31	86%	0.04	0.24	0.37
Winter 2022/2023	17	0.40	0.30	76%	0.04	0.24	0.36
	18	0.45	0.35	76%	0.04	0.28	0.41
	19	0.48	0.37	77%	0.05	0.29	0.45

Table 38 summarizes load impacts by season for each hour of the event for Group C (two event hours).

Table 38. Residential Charging Pilot Group C Summary of Hourly Per Season Load Impacts

Season	Hour	Modeled Baseline Load (kW)	Demand Impact (kW)	% Demand Impact	Standard Error	Lower Bound (90%)	Upper Bound (90%)
Winter 2021/2022	22	0.67	0.55	81%	0.11	0.38	0.73
	23	0.59	0.41	70%	0.08	0.28	0.56
Summer 2022	22	0.63	0.51	80%	0.07	0.38	0.62
	23	0.64	0.50	79%	0.08	0.36	0.60
Winter 2022/2023	22	0.61	0.44	72%	0.08	0.32	0.57
	23	0.55	0.38	70%	0.07	0.27	0.49

Table 39 summarizes load impacts by season for each hour of the event for Group C TOD (two event hours) for the Winter 2022/2023 Event Season. TOD load impacts are not being reported for summer 2022 and Winter 2021/2022 because model results showed that load impacts were not statistically significant during event hours. This is likely due to the low number of TOD customers left in Group A and C after cleaning for Summer 2022 and Winter 2021/2022 which did not allow the model to fully capture the consumption variation in these customers.

Table 39. Residential Charging Pilot Group C – TOD Summary of Hourly Winter 2022/2023 Load Impacts

Season	Hour	Modeled Baseline Load (kW)	Demand Impact (kW)	% Demand Impact	Standard Error	Lower Bound (90%)	Upper Bound (90%)
Winter 2022/2023	22	1.18	0.89	75%	0.26	0.46	1.31
	23	0.93	0.63	68%	0.30	0.14	1.12

Table 40 shows the model fit statistics of the final chosen model for each Group and Season.

Table 40. Residential Charging Pilot Summary of Model Fit Statistics by Group and Season

Season	Adjusted R squared	P Value	Number of Vehicles
Group B (EVSE)			
Winter 21/22	0.05	0.00	207
Summer 22	0.05	0.00	287
Winter 22/23	0.05	0.00	371
Group C			
Winter 21/22	0.04	0.00	211
Summer 22	0.05	0.00	441
Winter 22/23	0.06	0.00	697

APPENDIX A-III. OPT-OUT ANALYSIS

To understand event performance, the team conducted an analysis of participant opt-outs. We received connectivity data from Generac for the EVSE channel. Our review of that data revealed gaps and suspicious patterns, suggesting the data was unreliable. Generac was unable to supply additional data for the pilot's first three event seasons but did provide data from the Summer 2023 season, which we will explore as part of the 2024 evaluation.

WeaveGrid provided data on customer opt-outs based on several criteria. According to WeaveGrid, when a participant plugs in at home, they automatically have an optimized charging schedule set. The participant has the option to opt-out/override that schedule by selecting to "Charge Now" in a variety of ways, via SMS, the evPulse app or Tesla app, or through the charger if a customer has a smart charger. If a participant chooses to charge, they will charge until the charge is completed or the vehicle is unplugged, and they will not receive additional notice when it is a DR event. Through this definition, WeaveGrid may flag participants as an opt-out if they override a scheduled charge even if it did not lead to charging during the PGE event hours.

However, there may also be cases where WeaveGrid does not flag charging as an opt-out, despite the vehicle charging during the event. There are a few reasons for this.

- The first is insufficient slack. This occurs when a vehicle's ready-by-time requires the vehicle to charge during PGE event hours. In these cases, participants do not opt out of optimization because their optimized schedule was to charge during the event.
- The next is low battery protection. Some customers can select to have low battery protection, this means that whenever they plug in their car, if the state of charge is below 20% the car will charge immediately until it reaches that 20% level and then will begin optimized charging. The participant is not opt-outing out of optimization, so it is not flagged as an opt-out despite charging through an event.
- WeaveGrid also identified that there are cases where an optimized schedule fails to deliver to a participant, which may contribute to charging through events, but these would not be recorded as opt-outs because the participant did not intentionally opt-out of the charging schedule. In these cases, WeaveGrid notifies the customer of the error.

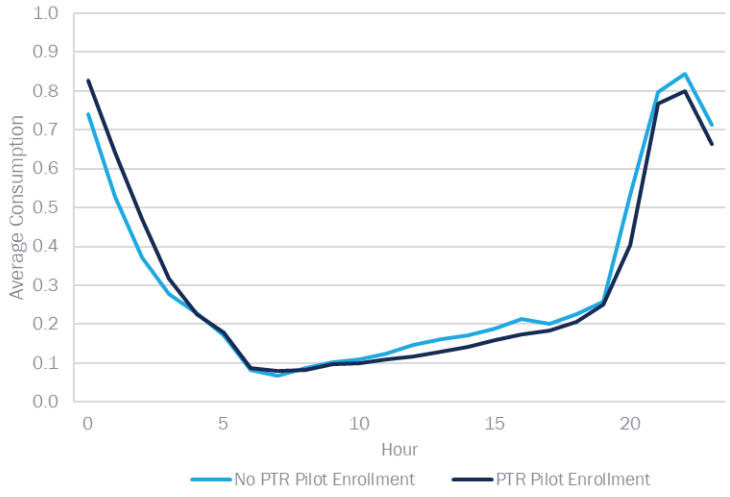
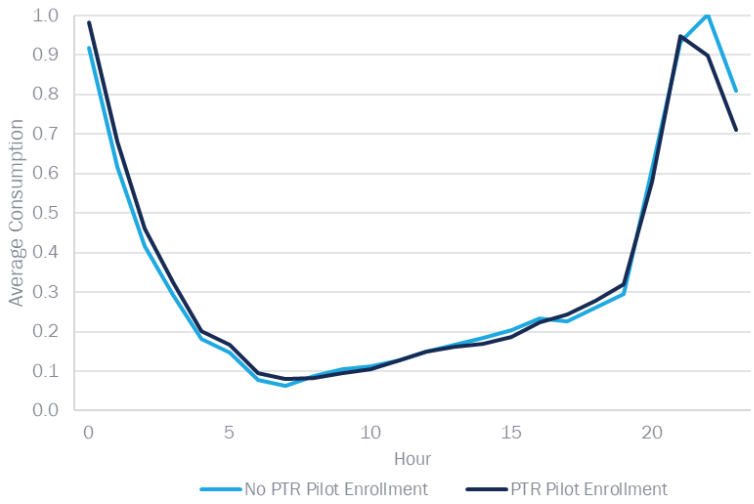
To be consistent across the two channels, for this evaluation, the team defined an event opt-out as participants that have greater than zero consumption during at least one hour of their PGE event window. For evPulse, away charging is excluded from this exploration since charging is not curtailed when the vehicle is not at home. We received hourly data for the EVSE channel and 15-minute data for evPulse. Given the level of data aggregation, we cannot identify customers who charged for just a few minutes. In future analyses, we could explore setting a minimum amount of charging during the hour to be classified as an opt-out.

As part of the 2024 evaluation, if connectivity data are reliable, we will explore event failures vs opt-outs. This exploration will help determine whether instances of event nonperformance can be attributed to technology and event execution issues or customer behavior.

APPENDIX A-IV. ADDITIONAL CHARGING PATTERN COMPARISONS

To explore participant charging patterns, we developed average hourly electricity consumption load curves for different customer segments and day types for each event season. We report on many of these segments in the body of the report and provide additional load shapes in this section for customers who participated in the PTR Pilot, and for evPulse participants, charging at home versus away from home.

Figure 48. Average Hourly Demand by Group, Event Season by PTR

Winter 2021/2022	
Summer 2022	
Winter 2022/2023	

The inclusion of away charging increases average hourly demand during the middle of the day, including during evPulse event hours. Since evPulse leverages vehicle telematics, we received EV charging interval data for charging at home and away from home ("away"). Average daily charging load at home only vs. at home and away are presented in Figure 49,

Figure 50, and

Figure 51. Participants enrolled in evPulse have different charging habits when charging away from home, the average hourly consumption peak occurs in the middle of the day relative to overnight that is observed in home charging. Notably, evPulse vehicles are not optimized when charging away from home.

Figure 49. Average Hourly Demand by Plug location – Winter 2021/2022

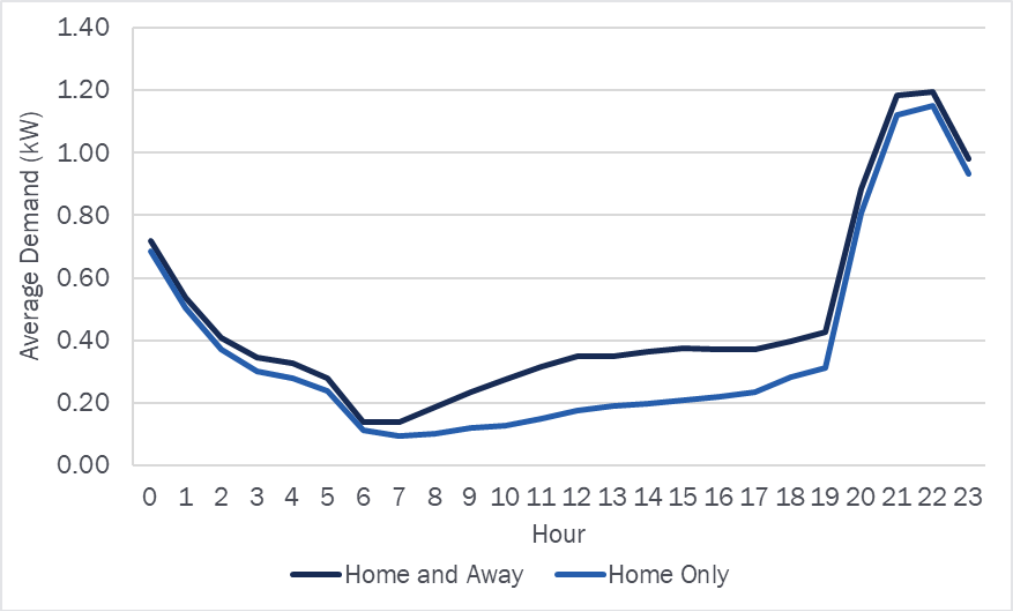


Figure 50. Average Hourly Demand by Plug location – Summer 2022

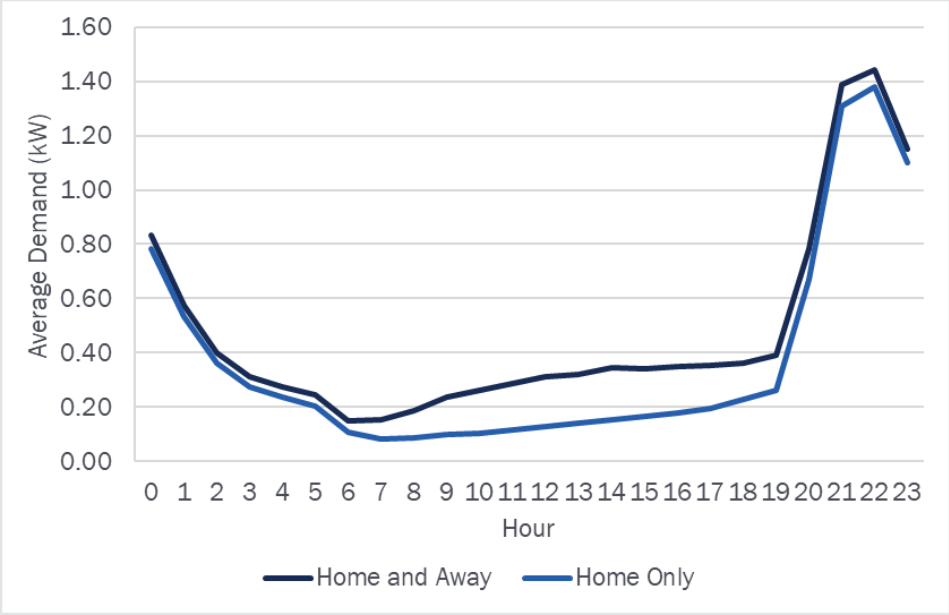
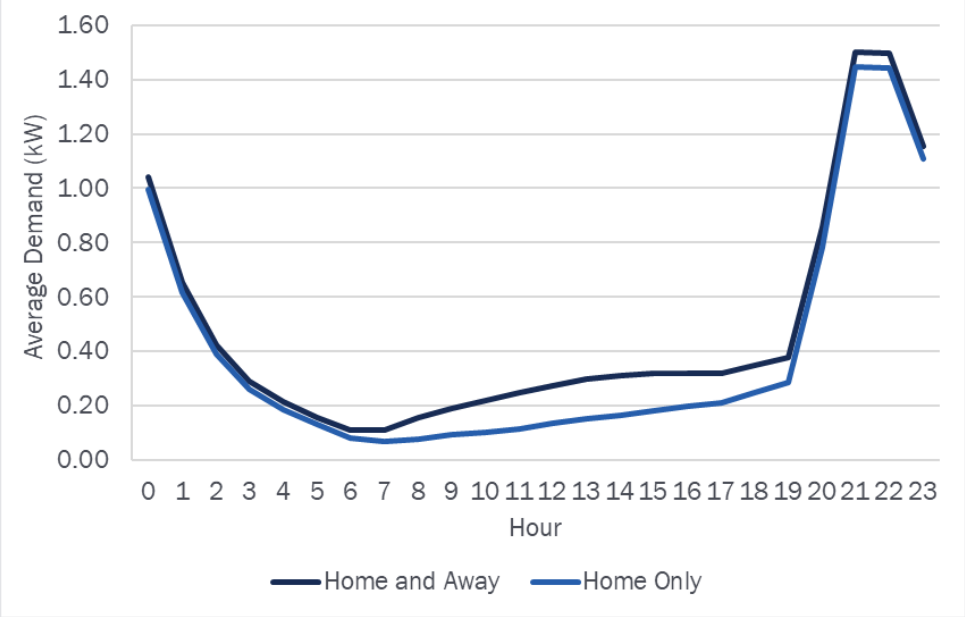


Figure 51. Average Hourly Demand by Plug location – Winter 2022/2023



APPENDIX A-V. PEAK PERIODS

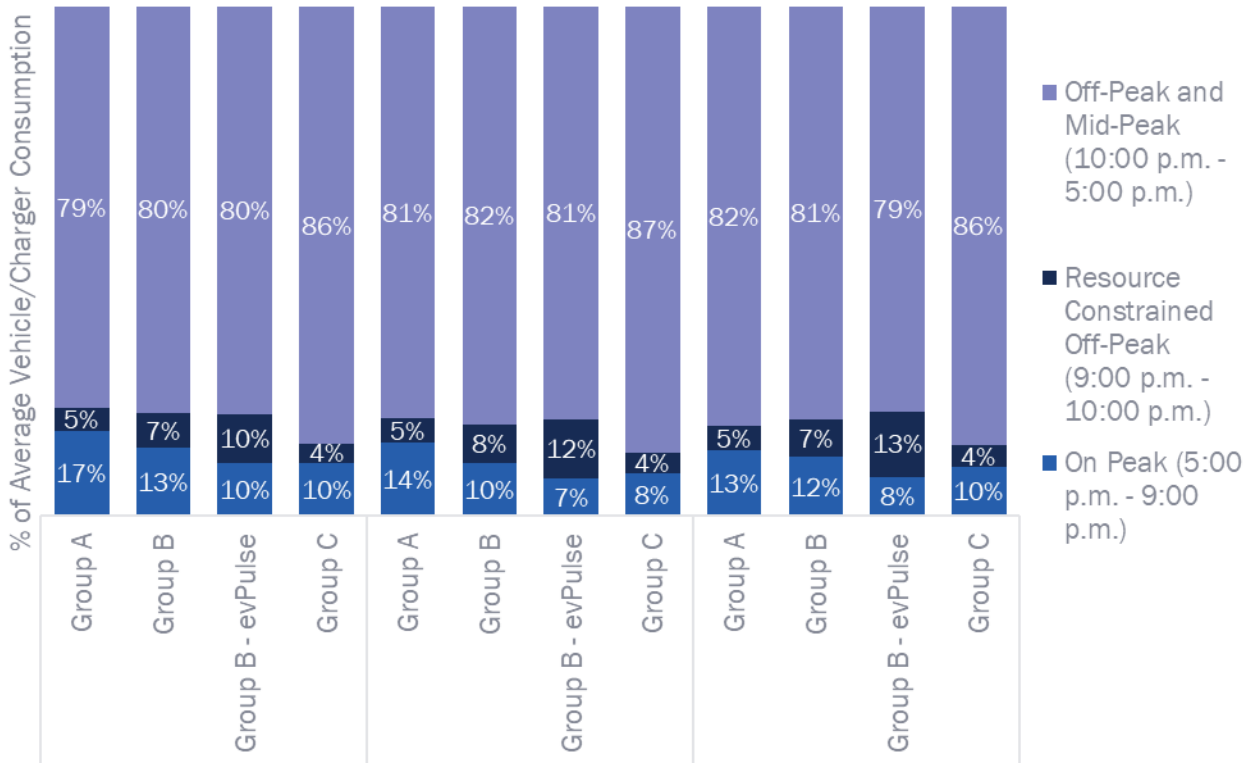
Figure 52 illustrates the percent of charging consumption by hour type for each Pilot group. Charging is broken down by on-peak (5:00 p.m.–9:00 p.m.), resource constrained off-peak (9:00 p.m.–10:00 p.m.), and off-peak/mid-peak (9:00 p.m.–5:00 p.m.).[33] The resource constrained hour is a period of time identified in PGE's IRP resource constraint model where there is high likelihood of future energy supply gaps. The resource constrained hour from 9:00 p.m. to 10:00 p.m. is not included in any of the event windows. Group B's window ends at 8:00 p.m. and the management of Group C does not begin until 10:00 p.m..

[33] Peak periods are defined based on PGE's residential TOD plan: https://portlandgeneral.com/about/info/pricing-plans/time-of-day.

Group B evPulse had the lowest percentage of on-peak consumption, however, it has the highest percent of charging during the off-peak resource constrained hour from 9:00 p.m. to 10:00 p.m., which is the beginning of off-peak for TOD.

Group C, which also has a higher percentage of TOD participants, has the second lowest usage during on-peak hours, but also the lowest share of consumption during the resource constrained hour. This pattern suggests that participants are shifting their charging overnight rather than earlier in the day to accommodate both TOD and their event window from 10:00 p.m. to 11:59 p.m.

Figure 52. Residential Percent Consumption by Hour Type and Group



Note: Excludes evPulse away charging and PTR event days.

APPENDIX B. BUSINESS CHARGING REBATES PILOT: IMPACT ANALYSIS METHODS AND CHARGING PATTERNS

APPENDIX B-I. CHARGING DATA CLEANING AND PREPARATION

Time Series Verification

The evaluation team verified the time series construction conducted by PGE. In doing so, we identified a small percentage of misalignment between the session and the constructed time series data. We concluded that the issues would not greatly impact results and the time series data was usable for the charging pattern analysis. Table 41 summarizes the steps and findings from our verification process.

Table 41. Business Charging Rebates Pilot Time Series Data Verification

Drop Reason	# of Sessions	% of Sessions Impacted	Comments
Initial Count	27,449	100%	Total number of unique sessions
Start times do not align	33	0.1%	In all cases, this was due to missing charging start information, preventing time series data creation for this session.
End times do not align	71	0.3%	In 33 cases, this was due to missing end-time information (same cases as above). Most cases were less than one hour different.
Durations do not align	1,640	6.0%	In some cases, the vendor-provided charging start and end time did not align with the provided charge duration. Given that the time series data is generated from charge start and end, we recalculated the charge duration to align with the start and end times. This reduced the count to 63 sessions (this includes the 33 cases with missing information).
The energy consumed does not align	63	0.2%	This includes the 33 cases with missing information because the missing end-time was required for the generation of the time series data. Therefore, in these cases, the constructed data has an energy consumption of 0.
Count of records that do not align	56	0.2%	This includes the 33 cases with missing information because the missing end-time was required for the generation of the time series data. Therefore, in these cases, the constructed data has a record count of only one despite the session length.

Session Data

The evaluation team relied on the comprehensive data extraction provided by PGE for session data. Since the same file was used for time series reconstruction which led to the duplication of sessions, we filtered the data to only session-level information and removed any duplicates to apply cleaning steps to the session data. As part of the session data cleaning, we reviewed the data for duplicate records, addressed gaps and conflicting information (where possible and reasonable), and subset the data to the relevant reporting period (pilot start through August 2023).

Table 42 summarizes cleaning steps made to the session data set as part of the data preparation and cleaning process. The cleaned session data is then used to update the time series data.

Table 42. Business Charging Rebates Pilot Session Data Cleaning Steps

Step	Type	Update/Drop	Remaining Unique Session IDs	Percent Remaining
Initial Count	NA	NA	27,449	100%
Invalid plug start and end times	Drop	3	27,446	100%
Missing charge start and end times	Drop	33	27,413	99.9%
Invalid charge start and end times	Drop	1	27,412	99.9%
Updating plug start times to align with charging start times	Update	1,878	27,412	99.9%
Updating plug end times to align with charging end times	Update	2	27,412	99.9%
Sessions with 0 seconds between plug start and end	Drop	44	27,368	99.7%
Sessions with 0 seconds between charging start and end	Drop	1,600	25,768	93.9%
Sessions with 0 consumption	Drop	120	25,648	93.4%
Subset data to the relevant time period	Drop	749	24,899	90.7%

Time Series Data

The cleaned session data was used to update the time series data. Sessions that were dropped in session data cleaning were also eliminated from the time series data, and any updated session information was applied to the time series data. Exact duplicates were also dropped. No cleaning was conducted on the charging start and end dates, so reconstruction of the data was not required. Once the time series data was updated, it was then aggregated to an hourly level, missing records were imputed, and the data was subset to the relevant reporting period. Days missing 24 hours of interval data were removed from the analysis.

APPENDIX B-II. CHARGING PATTERN ANALYSIS

Figure 53 - Figure 55 present additional average hourly electricity consumption load curves by segments and day types.

Figure 53. Business Charging Rebates Pilot Average Load Shapes per Day Type

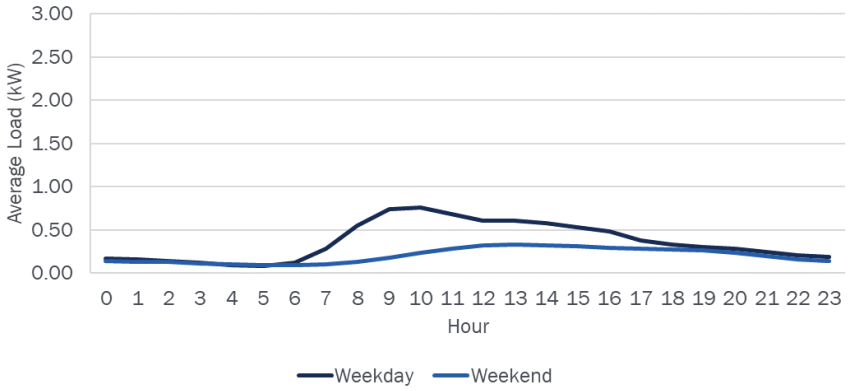


Figure 54. Business Charging Rebates Pilot Average Load Shapes per Customer Type

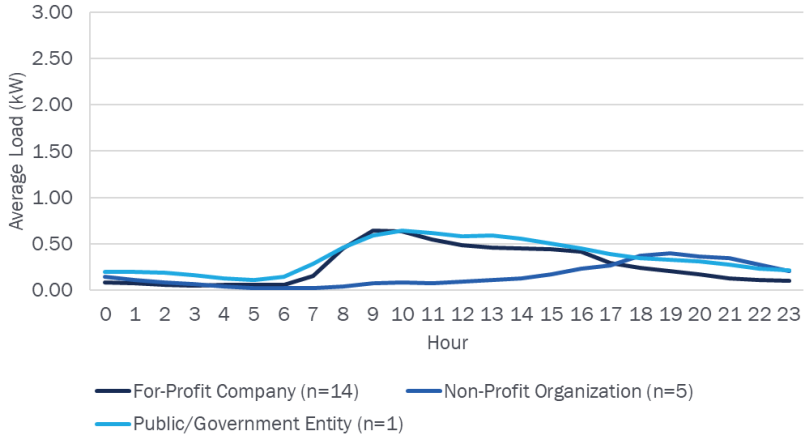


Figure 55. Business Charging Rebates Pilot Average Load Shapes per Rate

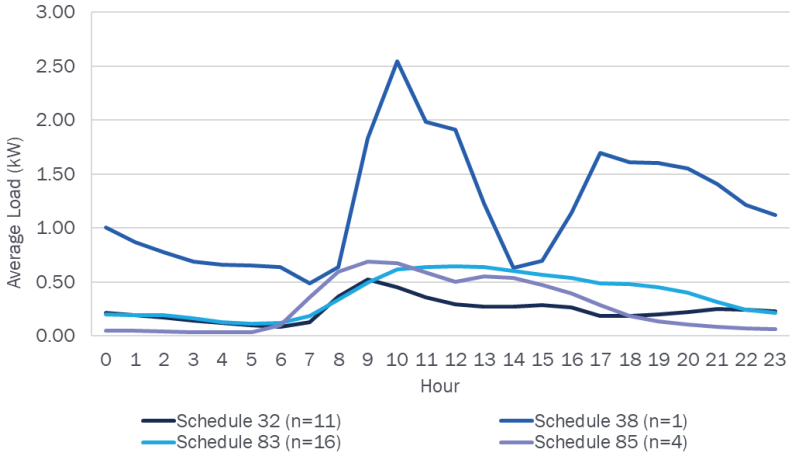


Table 43 presents the Business Charging Rebates Pilot participation data per customer through the end of August 2023.

Table 43. Business Charging Rebates Pilot Participation by Customer

Customer	Customer Type	Number of Sites	Number of Chargers	Chargers with Data
200046	Public/Government Entity	1	4	4
200049	Public/Government Entity	1	8	8
200050	For-Profit Company	1	2	1
200051	For-Profit Company	1	8	6
200052	For-Profit Company	1	2	1
200053	Public/Government Entity	2	3	3
200054	For-Profit Company	1	2	No data
200055	Public/Government Entity	1	1	1
200056	Non-Profit Organization	1	2	2
200057	For-Profit Company	5	6	5
200058	Public/Government Entity	1	9	9
200059	For-Profit Company	1	6	6
200060	Public/Government Entity	2	4	4
200061	Non-Profit Organization	1	1	No data
200062	Public/Government Entity	1	4	4
200063	For-Profit Company	1	8	8
200064	Non-Profit Organization	1	1	No data
200428	For-Profit Company	2	4	4
200448	For-Profit Company	1	2	1
201362	Public/Government Entity	4	5	4
201375	Non-Profit Organization	3	6	5
201376	Non-Profit Organization	1	1	1
201622	For-Profit Company	1	2	1
201623	For-Profit Company	2	12	No data
201776	Non-Profit Organization	1	4	No data
201777	For-Profit Company	1	3	No data
201806	For-Profit Company	1	3	3
201807	For-Profit Company	1	4	No data
201936	Non-Profit Organization	1	21	1

Table 44 presents the session summaries of the Business Charging Rebates Pilot participants per site through the end of August 2023.

Table 44. Business Charging Rebates Pilot Session Summaries by Site

Site	Use	Number of Sessions	First Charge	Last Charge	Average Charge Duration	Average Session Duration	Average Electricity Dispensed
100037	Fleet, Workplace, Public	1,045	8/19/2021	8/31/2023	2.14	2.62	11.21
100039	Public	73	4/4/2023	8/6/2023	3.35	5.57	18.10
100026	Fleet, Workplace, Public	1565	4/21/2022	8/31/2023	2.06	5.04	7.70
100024	Fleet, Workplace, Public	5626	3/29/2021	8/31/2023	3.40	5.85	14.84
100032	Multifamily	223	12/31/2020	8/31/2023	3.95	12.62	31.74
100031	Fleet, Workplace, Public	754	7/16/2021	8/31/2023	2.28	3.28	8.93
100034	Fleet, Workplace, Public	2760	8/5/2021	8/31/2023	1.97	2.23	8.79
100035	Fleet, Workplace, Public	1297	8/3/2021	8/31/2023	1.98	2.51	8.91
100038	Fleet, Multifamily, Workplace, Public	6786	9/5/2021	8/31/2023	2.78	5.77	13.58
100036	Fleet, Workplace, Public	557	8/17/2021	8/31/2023	1.79	2.05	7.72
100028	Public	859	11/23/2021	9/1/2023	4.52	5.79	23.32
100029	Public	330	11/23/2021	8/16/2023	3.73	4.49	23.22
100027	Fleet, Workplace, Public	64	1/25/2023	8/9/2023	2.52	3.36	17.53
100025	Workplace	496	3/29/2022	8/30/2023	3.66	6.46	19.64
100033	Fleet, Workplace, Public	249	8/31/2021	8/29/2023	1.61	1.83	8.46
100043	Fleet, Workplace, Public	980	4/3/2023	9/1/2023	2.07	2.44	10.11
100040	Workplace, Public	39	4/5/2023	8/31/2023	2.43	10.19	8.94
100041	Workplace, Public	98	4/3/2023	8/31/2023	3.91	5.11	15.93
100044	Workplace	393	4/1/2023	9/1/2023	3.68	5.01	16.49
102189	Public	19	7/9/2023	8/30/2023	2.32	2.98	12.20
102194	Public	3	7/11/2023	8/17/2023	0.79	1.49	4.06
102191	Public	15	7/24/2023	8/31/2023	1.74	1.82	9.08
103052	Multifamily	50	8/1/2023	9/1/2023	1.81	1.94	9.21
100648	Public	26	4/3/2023	8/24/2023	2.03	2.31	13.70
100645	Public	260	4/1/2023	8/30/2023	1.20	1.48	6.84
102773	Public	3	8/16/2023	8/30/2023	1.59	1.66	9.64
102193	Public	47	7/6/2023	8/31/2023	2.69	2.80	16.27
102192	Public	2	8/3/2023	8/16/2023	2.55	2.55	14.87
102197	Public	6	7/6/2023	8/27/2023	2.07	2.95	10.58
102195	Multifamily	13	7/3/2023	8/29/2023	3.14	3.35	32.95
100010	Fleet	243	5/31/2023	9/1/2023	12.09	15.19	45.07
103364	Multifamily	1	8/31/2023	9/1/2023	6.43	16.95	42.02
100649	Multifamily	16	7/1/2023	8/30/2023	4.72	8.83	16.06

Table 45 presents the energy consumption summaries of the Business Charging Pilot participants per site through the end of August 2023.

Table 45. Business Charging Rebates Pilot Energy Consumption per Site

Site	Total Consumption	Average Number of Ports	Off Peak %	On Peak %	Rate	Site Use
100010	10,476	4	32%	68%	Schedule 38	Fleet
103052	357	4	74%	26%	Schedule 83	Multifamily
100648	277	2	71%	29%	Schedule 83	Public
100645	1,699	2	68%	32%	Schedule 83	Public
102197	18	2	59%	41%	Schedule 83	Public
100043	9,753	4	40%	60%	Schedule 83	Fleet; Workplace; Public
100038	91,597	14	32%	68%	Schedule 83	Fleet; Multifamily; Workplace; Public
102189	183	2	28%	72%	Schedule 83	Public
100036	4,279	2	23%	77%	Schedule 83	Fleet; Workplace; Public
100027	1,106	1	22%	78%	Schedule 83	Fleet; Workplace; Public
100034	24,180	2	21%	79%	Schedule 83	Fleet; Workplace; Public
102193	637	2	16%	84%	Schedule 83	Public
100037	11,679	2	15%	85%	Schedule 83	Fleet; Workplace; Public
100035	11,545	2	12%	88%	Schedule 83	Fleet; Workplace; Public
102191	123	1	9%	91%	Schedule 83	Public
102194	10	1	0%	100%	Schedule 83	Public
102192	-	1			Schedule 83	Public
100039	1,107	4	59%	41%	Schedule 85	Public
100044	6,285	6	28%	72%	Schedule 85	Workplace
100024	83,154	13	11%	89%	Schedule 85	Fleet; Workplace; Public
100031	6,702	2	4%	96%	Schedule 85	Fleet; Workplace; Public
102773	9	1	NA	NA	Schedule 32	Public
100649	235	1	NA	NA	Schedule 32	Multifamily
102195	422	1	NA	NA	Schedule 32	Multifamily
100028	19,977	2	NA	NA	Schedule 32	Public
100029	7,580	2	NA	NA	Schedule 32	Public
100032	7,203	2	NA	NA	Schedule 32	Multifamily
100033	2,080	2	NA	NA	Schedule 32	Fleet, Workplace, Public
100040	291	2	NA	NA	Schedule 32	Workplace, Public
100041	1,541	2	NA	NA	Schedule 32	Workplace, Public
100026	11,954	6	NA	NA	Schedule 32	Fleet, Workplace, Public

Note: Peak time periods, as defined by Schedule 85 – Time of Use Rate, are from 6:00am – 10:00pm Monday through Saturday.

Table 46 presents the utilization summaries of the Business Charging Rebates Pilot sites. Utilization rates are calculated between a charger's first recorded session and their last recorded session, which are listed in Table 44.

Table 46. Business Charging Rebates Pilot Port Utilization per Site

Site	Use	Number of sessions	Charge utilization (through the latest session)	Plug utilization (through the latest session)
100037	Fleet, Workplace, Public	2	6.4%	7.8%
100039	Public	5	2.1%	3.5%
100026	Fleet, Workplace, Public	6	4.5%	11.1%
100024	Fleet, Workplace, Public	14	6.8%	11.6%
100032	Multifamily	2	1.9%	6.0%
100031	Fleet, Workplace, Public	2	4.6%	6.6%
100034	Fleet, Workplace, Public	2	15.1%	17.0%
100035	Fleet, Workplace, Public	2	7.1%	8.9%
100038	Fleet, Multifamily, Workplace, Public	18	7.5%	15.9%
100036	Fleet, Workplace, Public	2	2.8%	3.3%
100028	Public	2	12.5%	16.1%
100029	Public	2	4.1%	5.0%
100027	Fleet, Workplace, Public	1	3.4%	4.6%
100025	Workplace	2	7.3%	12.9%
100033	Fleet, Workplace, Public	2	1.2%	1.3%
100043	Fleet, Workplace, Public	4	14.0%	16.5%
100040	Workplace, Public	2	1.6%	7.4%
100041	Workplace, Public	2	5.3%	7.0%
100044	Workplace	7	5.8%	8.0%
102189	Public	2	1.8%	2.4%
102194	Public	1	0.3%	0.5%
102191	Public	1	5.9%	6.2%
103052	Multifamily	4	4.1%	4.4%
100648	Public	3	1.2%	1.3%
100645	Public	4	7.0%	7.8%
102773	Public	1	1.3%	1.4%
102193	Public	2	4.7%	4.9%
102192	Public	1	1.6%	1.6%
102197	Public	2	0.6%	0.8%
102195	Multifamily	1	3.0%	3.2%
100010	Fleet	4	33.2%	41.6%
100649	Multifamily	1	5.2%	9.7%

APPENDIX C. FLEET PARTNER PILOT: IMPACT ANALYSIS METHODS AND CHARGING PATTERNS

APPENDIX C-I. DATA CLEANING AND PREPARATION

Time Series Verification

The evaluation team verified the time series construction conducted by PGE. We identified a no misalignment between the session and constructed time series data.

Session Data

The evaluation team relied on the comprehensive data extract provided by PGE for session data. Since the same file was used for time series reconstruction, which led to the duplication of sessions, we filtered the data to only session-level information and removed any duplicates to apply cleaning steps to the session data. As part of the session data cleaning, we reviewed the data for duplicate records, addressed gaps and conflicting information (where possible and reasonable), and subset the data to the relevant reporting period (pilot start through August 2023).

Table 47 summarizes cleaning steps made to the session data set as part of the data preparation and cleaning process. The cleaned session data is then used to update the time series data.

Table 47. Fleet Partner Pilot Session Data Cleaning Steps

Step	Type	Update/Drop	Remaining Unique Session IDs	Percent Remaining
Initial Count	NA	NA	285	100%
Invalid plug start and end times	Drop	0	285	100%
Missing Charge Start/End Times	Drop	0	285	100%
Invalid Charge start and end times	Drop	0	285	100%
Updating plug start times to align with charging start times	Update	44	285	100%
Updating plug end times to align with charging end times	Update	0	285	100%
Sessions with 0 seconds between plug start and end	Drop	0	285	100%
Sessions with 0 seconds between charging start and end	Drop	1	284	99.6%
Sessions with 0 consumption	Drop	3	281	98.5%
Subset data to the relevant time period	Drop	36	245	86.0%

Time Series Data

The cleaned session data was used to update the time series data. Sessions that were dropped in session data cleaning were also eliminated from the time series data and any updated session information was applied to the time series data. Exact duplicates were also dropped. No cleaning was conducted on the charging start and end dates, so reconstruction of the data was not required. Once the time series data was updated, it was then aggregated to an hourly level, missing records were imputed, and the data was subset to the relevant reporting period. Days missing 24 hours of interval data were removed from the analysis.

APPENDIX C-II. CHARGING PATTERN ANALYSIS

Figure 56 and Figure 57 present additional average hourly electricity consumption load curves by day type and site.

Figure 56. Fleet Partner Pilot Average Load Curves per Day Type

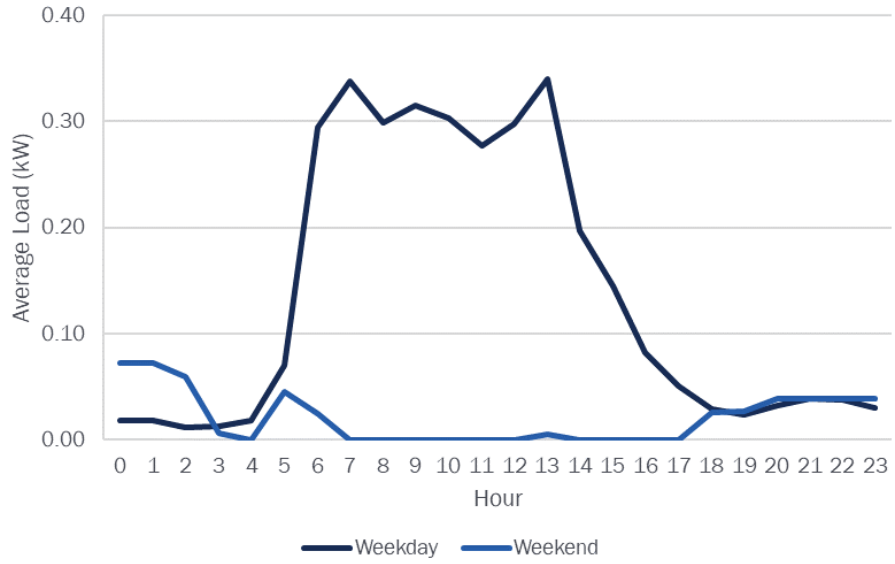
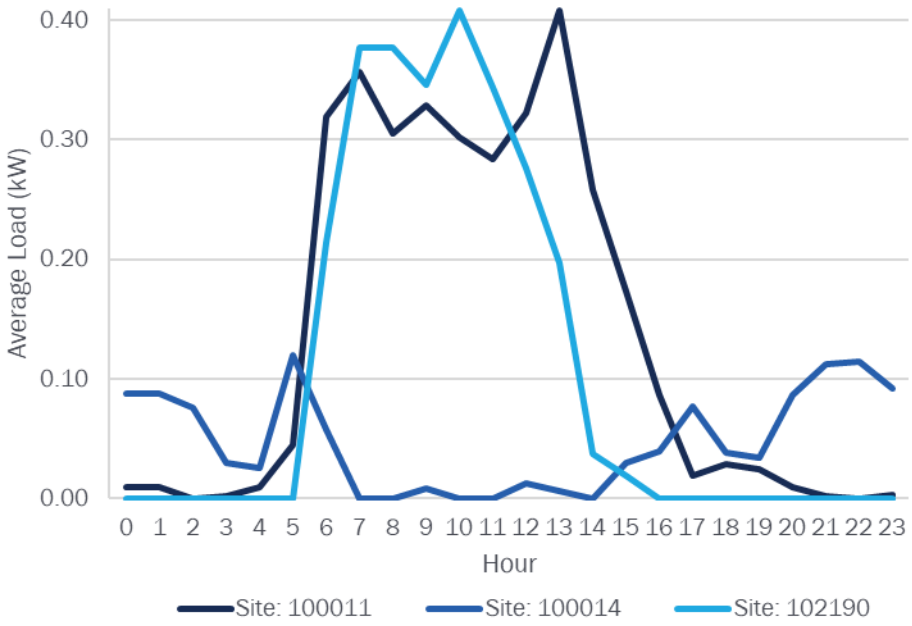


Figure 57. Fleet Partner Pilot Average Load Curves per Site



APPENDIX D. FLEET PARTNER PILOT: INTERIM FINDINGS

APPENDIX D-I. INTRODUCTION

This memorandum summarizes the findings from in-depth interviews that Opinion Dynamics conducted with fleet managers who have either permanently or temporarily disengaged with Portland General Electric's (PGE) Fleet Partner Pilot, as well as interviews with pilot staff. Additionally, this memo presents findings from secondary research conducted on current fleet electrification programs offered by peer-utilities, including documenting program requirements and incentive levels.

PGE's Fleet Partner Pilot aims to reduce costs and complexities for managers of nonresidential fleets who are interested in transitioning to electric fuel and create a network of demand response (DR) enabled electric vehicle (EV) charging that can support efficient grid operations and future renewables integration. There are two components of the Fleet Partner pilot:

- **Fleet Partner Plan:** Includes EV feasibility assessments, vehicle operations and charging analyses, fuel cost and clean fuel credit analyses, site walkthroughs, design and cost estimates, and an incentive summary delivered in a comprehensive Fleet Partner Study.
- **Fleet Partner Build:** Customers who complete a Fleet Partner Study can join the reservation list for the Build phase, which includes turnkey final design, construction of make-ready infrastructure, incentives, and PGE ownership of make-ready.

Opinion Dynamics conducted interviews with pilot staff, inactive fleet managers, and secondary research to provide PGE with early feedback on reasons for pilot attrition and non-participation in the Fleet Partner Pilot, which PGE can use to adjust the pilot design if needed. In addition to the evaluation activities covered in this memo, we will conduct interviews with pilot participants who completed the Build phase of the pilot, field surveys with participants who completed a Fleet Partner Study, and conduct an analysis of installed charging load data, pending data availability. We will present findings from these additional evaluation activities in the 2023 Annual Report.

APPENDIX D-II. RESEARCH METHODS

APPENDIX D-II.I. IN-DEPTH INTERVIEWS

Between April and May of 2023, Opinion Dynamics conducted in-depth interviews with eight Fleet Partner Pilot staff, including the product manager, key customer managers (KCMs), engineering, marketing, and business outreach staff. The interview objectives were to better understand PGE's progress towards meeting the participation goals set for the Fleet Partner Pilot, highlighting the successes and challenges of the pilot since its launch.

In May of 2023, the research team conducted in-depth interviews with four of five fleet managers who inquired about the Fleet Partner Pilot, applied, but withdrew their application. The interviews included questions about pilot marketing efforts, reasons for withdrawing from the pilot, participation challenges that PGE could address, the appropriateness of the custom incentive for make-ready infrastructure, and the usefulness of the online Total Cost of Ownership (TCO) planning tool. The team recruited interviewees via email from a PGE-provided list of five contacts who withdrew from the pilot. All interviewees were offered a $100 incentive for completing the interview.

Inactive fleet managers reported managing fleets in PGE's service area of various sizes, which they utilize for a variety of commercial purposes (Table 48). Three of the four interviewees manage only light- or medium-duty commercial

vehicles while the remaining interviewee manage heavy-duty industrial vehicles. Two interviewees had existing EVs as part of their fleets, while the others had only gas or diesel vehicles.

Table 48. Inactive Fleet Manager Interviewee Characteristics

Property Type	Type of Organization	Type of Fleet Vehicles	Current EVs	Approximate Fleet Size
Commercial	Transit Bus Contractor	School buses & motorcoaches	0	845
Commercial	Electrical Contractor	Transit vans	0	355
Municipal	Recreation & Park District	Passenger & industrial vehicles	4 EVs, 3 PHEVs	100
Commercial	Auto Dealership	Passenger vehicles	8 EVs	8[b]

[a] This interviewee mentioned that they already have eight EVs and wanted to know if the pilot could provide incentives for upgrading their existing charging.

APPENDIX D-II.II. OPTIMAL INCENTIVE LEVEL RESEARCH

In addition to asking inactive fleet managers for their opinion on current Fleet Partner make-ready incentive levels, Opinion Dynamics conducted a review of other utility fleet electrification programs in the United States to document incentive levels offered by other utilities. We reviewed 13 utility programs, documenting program requirements, incentive types, and incentive levels.

APPENDIX D-III. KEY FINDINGS AND RECOMMENDATIONS

This section summarizes the overarching findings from interviews with pilot staff and inactive fleet managers and secondary research on peer-utility fleet electrification programs.

- Key Finding #1: Pilot staff mentioned two key challenges that the pilot is currently facing: a shortfall in available funding and supply chain issues. As of January 2023, funding for make-ready build-out was exhausted, leading to some customer frustration. Pilot staff hope to receive additional funding as part of the new Transportation Electrification Plan but expect to make changes to make-ready incentive levels. Additionally, staff mentioned challenges with extended delays in procuring equipment, including transformers and switchgear, leading to elongated project timelines.
- Key Finding #2: Current make-ready incentive levels likely could be decreased given the high demand for the pilot. Pilot staff reported that funding for the Build phase of the pilot was quickly exhausted and that with the current backlog of potential participants, the next round of funding will be exhausted with little additional marketing and outreach. Further, interviewed fleet managers reported that the amount of incentive offered through the pilot was not a contributing factor in their decision to withdraw their participation. Secondary research conducted by the research team suggests that current incentive levels align with other utility program offerings, however, making direct comparisons is challenging due to the variety of program and incentive configurations of fleet electrification utility programs.
    - Recommendation: Consider decreasing current make-ready incentive levels to allow for greater participation in the pilot. Additional research conducted with Plan and Build phase participants in 2023 can be leveraged to provide additional insights into optimal incentive levels.
- Key Finding #3: PGE KCMs and business outreach staff are currently key to generating leads for the Fleet Partner Pilot. Nearly all projects supported by the Fleet Partner Pilot were initiated by PGE staff, with few customers reaching out directly to PGE to inquire about electrification offerings. However, KCMs and business outreach staff mentioned challenges with staying up to date on current offerings and suggested better

coordination between KCMs and pilot staff so KCMs can better assist with the application and enrollment process. Direct outreach activities to customers include presentations and social media outreach (i.e., LinkedIn).

- Recommendation 1: Consider providing regular updates to KCMs and business outreach staff about current transportation electrification offerings and updates on program requirements and incentive levels. Because KCMs and business outreach staff have established relationships with customers, consider closer coordination during the participation process, including involving staff in project kickoff meetings and providing project status email updates.
- Recommendation 2: If additional funding becomes available, PGE could consider exploring alternative ways of engaging with fleets in its service territory.

- Key Finding #4: Meeting the 70 kW energy-use commitment is a key barrier mentioned by interviewed fleet managers and pilot staff. Some fleet managers reported that based on their current fleet vehicle utilization data, they would be unable to meet the energy consumption requirement within the timeframe specified by the pilot and withdrew their application.
  - Recommendation: After customers with large fleets are served, PGE may want to consider altering the Fleet Partner Pilot participation requirements to allow for increased participation of customers with smaller fleets. If smaller fleets are allowed to participate, consider adjusting incentive levels to support cost effectiveness for smaller charging loads.

APPENDIX D-IV. DETAILED INTERVIEW FINDINGS

- This section summarizes the findings from interviews with pilot staff and inactive fleet managers.

APPENDIX D-IV.I. PILOT CHALLENGES

Funding for make-ready build-out was exhausted in early 2023, leading to customer frustration. Many eligible participants on the reservation list for the Build phase are waiting for funds to come available to proceed. Pilot staff have found it challenging to communicate the funding issue to customers on the reservation list because of the risk of discouraging committed and eligible customers from continuing their participation. Moreover, when funding is available incentive levels will be reduced, which may cause customers to reconsider moving forward with the Build phase.

Supply chain issues associated with charging infrastructure equipment have increased project timelines and costs. Procuring charging infrastructure equipment has been difficult for the past couple of years due to global supply chain issues. Staff have seen delays in deliveries of transformers of up to 56 weeks and switchgears of up to 65 weeks. These long delays contributed to discrepancies between the estimated and actual costs for a handful of projects during the first Fleet Partner Pilot's infancy. One interviewed fleet manager mentioned that this is essentially a manufacturing problem that the pilot cannot alleviate. Still, staff mentioned that ordering equipment months ahead of the expected delivery date has helped with equipment deliveries and capital planning.

APPENDIX D-IV.II. AWARENESS OF FLEET ELECTRIFICATION AND PARTICIPATION BENEFITS

KCMs and business outreach staff play a key role in promoting the Fleet Partner Pilot by sharing information with their customers who have fleets. Customers have established relationships with KCMs and business outreach staff, and tend to consult them first to learn about PGE's offerings. Two of the interviewed fleet managers learned about the Fleet Partner Pilot from PGE staff. Another fleet manager reached out to PGE because one of their clients wanted to form a

partnership with them, PGE, and the school district to install make-ready infrastructure for electric school buses. The other fleet manager learned about the pilot from other municipalities.

Email outreach has been effective at raising awareness for fleet electrification and participation benefits among eligible customers. The product team's Salesforce dashboard, which tracks outbound communications, has been vital to this approach. Additional ways customers could have learned about the pilot include online searches for fleet electrification that lead to the PGE website, annual business review presentations, LinkedIn postings, and tabling at the 2022 Green Transportation Summit and Expo.

- KCM and business outreach staff need help to stay current on PGE transportation electrification offerings and want to be more involved during the participation process to support their customers. KCMs and business outreach staff would like more information about PGE's transportation electrification offerings. They would also like to be more involved during the Fleet Partner Pilot participation process, including attending their customers' project kickoff meetings. KCMs and business outreach staff suggested that pilot staff include them in project meetings and provide regular updates about changes to the pilot, so they can provide customers with accurate information and communicate customer needs.

APPENDIX D-IV.III. CHALLENGES TO FLEET ELECTRIFICATION AND PILOT PARTICIPATION

- The pilot's energy-use commitments are preventing some organizations from participating in the Fleet Partner Pilot. A requirement to participate in the Fleet Partner Pilot is to add a minimum of 70 kW of new load (usually equivalent to 10 Level 2 ports or 1-2 DC fast chargers) at the customer site. Two interviewed fleet managers were ineligible for the pilot due to the energy-use commitment. One interviewee elaborated, saying that after doing their own calculations using their fleet maintenance provider's vehicle management portal and EV fleet vehicle manufacturer data, they found that they could not meet the minimum 70 kW load requirement.

> "When we first, initially, were talking with them, we're kind of like, "Oh, yeah, maybe we could do a couple of vehicles, a couple SUVs, and then a couple of trucks… We went from thinking about 50 miles a day as the base, but we found out it was more like 15."

The other interviewee was hesitant to agree to the energy-use commitment because their company (a car dealership) was unlikely to use more EVs and/or chargers in the future. The customer was able to procure project funding via federal tax credits, which was a better fit for their needs.

> "I felt like I was stepping into a grey area because the pilot is not designed for car dealers… the intention of the pilot was to electrify a limo company or a bus company or a garbage hauling company. I understood what the intention of the pilot was as I got into it more, but I was looking for help."

- Changes in staffing at customer organizations during the participation process have been an ongoing challenge for fleet electrification and participation. Staff turnover at potential participant organizations can lead to missing funding opportunities. For example, a large organization that enrolled in the pilot replaced all project leads, and when the time came for the organization to sign and submit their application for funding, new staff were not familiar with the project. Pilot staff also find that it becomes increasingly difficult to get project approval when an organization adds more staff to the internal approval process.
- The initial staffing arrangement for Design Project Managers (DPMs) hindered fleet electrification and participation. The DPM team oversees utility infrastructure plans for every project in the Fleet Partner Pilot during the Plan phase. There was only one DPM available last year to work with contractors on final project designs. While the sole DPM performed high-quality work, they were overcapacity given the influx of fleet projects prompting pilot staff to bring in regional DPMs. The addition of regional DPMs has led to reduced project delays.

- For some organizations, the lack of a central charging location for their remotely located fleet vehicles is a major barrier to fleet electrification and participation. While it is not a common issue, there are some organizations that struggle to provide charging assistance to employees who take their fleet vehicles home. To overcome this challenge, some organizations plan to build centralized charging depots for employees to charge fleet vehicles.
- Having greater flexibility in choosing qualified contractors could increase participation. One interviewed fleet manager who worked for an electrical contracting company withdrew from the pilot because they could not come to an agreement with PGE on completing the Build phase themselves, rather than choosing a direct competitor from the list of pilot-approved contractors. They mentioned that they would have continued with the pilot if PGE had not denied their request to install the purchased equipment themselves.

"It's perception more than anything… The approved contractors were our direct competition. I think the experience, up to the point we couldn't agree on terms, was fine… if we weren't an electrical contractor, it would probably already be in process. We'd probably be installing.".

Satisfying grid interconnection agreements and feasibility testing can be a challenge for some projects. One interviewed fleet manager mentioned that a distributed energy project that they launched while also working with the pilot was temporarily put on hold when an important customer contract for establishing grid interconnections was lost. While the fleet manager said that this issue was later resolved by regaining the contract, they also mentioned feasibility testing for the vehicle-to-building (V2B) and vehicle-to-grid (V2G) switchgear technology was time-consuming and delayed due to supply chain constraints.

APPENDIX D-IV.IV. CURRENT MAKE-READY REBATE LEVELS

Current incentive levels were sufficient and not a reason why interviewed fleet managers withdrew from the pilot. All interviewed fleet managers reported that that they withdrew from the pilot for reasons unrelated to incentives. Of the four interviewees, two said that their withdrawal from the pilot was due to the 70 kW energy-use commitment requirements discussed above. The fleet managers reiterated that their fleets' actual mileage use was too low to meet the pilot requirement.

APPENDIX D-IV.V. FUTURE FLEET ELECTRIFICATION PLANS

Three of the four fleet managers indicated that they have no further fleet electrification plans. The customer who still has electrification plans manages the largest fleet among the interviewees and stated that they are striving to be a leader in fleet electrification within their industry. The company is doing work to set up the make-ready infrastructure needed to support future electrified fleet vehicles that they will be procuring slowly over many years. This customer mentioned a new project with the Fleet Partner Pilot, and that they are currently working with PGE staff and partners to conduct a feasibility test for specific equipment to establish the interconnection agreement required to proceed to the Build phase.

APPENDIX D-V. REVIEW OF PEER-UTILITY FLEET PROGRAMS

Opinion Dynamics reviewed the program designs and incentive levels for 13 different fleet electrification programs offered by utilities across the United States. Utility fleet electrification programs come in several different configurations based on the energy goals and financial needs of the businesses that the electric utilities serve. As a result, utilities offer a variety of incentives for EV make-ready infrastructure, EV supply equipment (EVSE) procurement, and electric fleet vehicles.

A key objective of this research was to identify typical incentive levels for fleet programs. Given the varied program designs and incentive levels, we were unable to identify a typical incentive level. Below, we summarize the key program design elements and range of incentives for current fleet electrification offerings. In addition, Table 49 provides a summary of the 13 programs reviewed allowing for a comparison of these programs with the Fleet Partner Pilot's participation requirements and incentive levels.

- Similar to PGE's Fleet Partner Pilot, all utility programs reviewed provided fleet electrification assessments.
- Eight out of thirteen fleet electrification programs offer incentives for both make-ready infrastructure and EVSE projects, with four offering additional incentives for electric fleet vehicle procurement. Additionally, one program provided grant-finding and writing support for EVSE projects.
- Maximum incentive levels for make-ready infrastructure projects varied based on customer charging needs, the type of community that the proposed project would serve, and the type of fleet vehicles that would use the charging infrastructure. Eligible customers enrolled in these programs may receive incentives covering anywhere between 50% to 100% of the upfront costs for make-ready projects.
- EVSE incentive levels varied by utility, ranging from $500 to $4,500 per serviced Level 1 or Level 2 charger and $7,500 to $30,000 for DC fast chargers.
- Individual program requirements varied by utility. For example, ten programs required that customers are responsible for annual maintenance costs while the remaining three required that the customers agree to transfer that responsibility to the utility, which is typically associated with no-cost installation of the make-ready infrastructure.

Table 49. Summary of Utility Fleet Program Offerings

Program Name	Utility	Program Offerings				Program Requirements	Program Incentive Levels
		Assess-sment	Make-Ready	Chargers	EVs		
Fleet Partner Pilot (Phase 1)	Portland General Electric	✓	✓	-	-	Charging site(s) must be in PGE service area and customers are responsible for charger costs, annual maintenance costs, electricity costs, and any make-ready costs not covered by the custom cost incentive. Customers must meet make-ready design of at least 70 kW of connected load (usually equivalent to 10 Level 2 ports or 1-2 DC fast chargers) and share charging data with PGE for 10 years, commit to forecasted energy use of the chargers and sign an easement covering PGE-owned infrastructure as well as agree to terms of Participation Agreement.	**Make-ready:** Up to $750,000 or the make-ready costs per customer, whichever is less. The higher the energy use commitment, the higher the incentive could be.
PowerMIFleet Pilot	Consumers Energy	✓	✓	✓		Customers are responsible for charger costs, annual maintenance costs, and ongoing electricity costs. Must add at least one EV to fleet while still participating in program, within 6 months of notifying utility of rebate selected. Customer must have existing make-ready infrastructure on the property to take advantage make-ready rebates.	**Make-ready:** Rebates to reduce costs of upgrading existing make-ready infrastructure if customer agrees to install chargers. **Chargers:** Up to $5,000 per L2 (limit 10 per site), $35,000 per non-public DCFC, and $70,000 per public-use DCFC.
eFleet Charger Rebate Program	DTE Energy	✓	-	✓		Customers are responsible for charger costs, annual maintenance costs, and ongoing electricity costs for at least 5 years after the installation date.	**Chargers:** Up to $2,500 for L2 and up to $70,000 for DC fast chargers. Rebate amounts capped to DTE Energy's discretion at a maximum level per site and per participant if installing L2 or DCFC EVSE.
Electric Transportation Make Ready Program	Georgia Power	✓	✓	✓		Customers agree to have make-ready infrastructure installed, owned, and operated by utility. Chargers must be in an area that property owners agree the general public may access. Restricted access chargers	**Make-ready:** Capped at $200,000 per project. A Contribution in Aid of Construction (CIAC) charge is imposed on the requesting customer for anything over the cap to cover any differences. **Chargers:** Up to $500 for

Program Name	Utility	Program Offerings				Program Requirements	Program Incentive Levels
		Asses-sment	Make-Ready	Chargers	EVs		
						are not eligible for Make Ready program infrastructure funding. Privately owned fleets are not eligible. Customers are responsible for charger costs, annual maintenance costs, and ongoing electricity costs. The program requires a minimum of six chargers(ports) for a Level 2 charger or at least one DC fast charger. Anything less will be eligible for the charger rebate program.	each L2 charger (Max total of $2,500 per account).
EV Make-Ready Program	Joint Utilities of New York	✓	✓	✓		Customers are responsible for charger costs, annual maintenance costs, and ongoing electricity costs.	**Make-ready and Chargers:** 3-tiered Incentive up to 100% cost reduction of make-ready largely based on type of community, number of ports, and charger type. Incentive cap depends on the utility, but all caps are under $6,000 for L2 and $8,000 for DCFC chargers.
Fleet Advisory Services and Charging Program	National Grid USA	✓	✓			Customers are responsible for charger costs, annual maintenance costs, and ongoing electricity costs.	**Make-ready**: 3-tiered incentive up to 100% of make-ready funding for eligible light-duty fleets and up to 90% of utility-side make-ready costs for medium and heavy-duty fleets.
EV Fleet Program	Pacific Gas and Electric (PG&E)	✓	✓	✓		Customers must provide property easement and acquire at least 2 medium- or heavy-duty EVs by 2024. Customers provide EV utilization data for at least 5 years after charger activation and operate/maintain chargers of min 50 kW charging capacity for at least 10 years.	**Make-ready:** Up to $9,000 in funding for to-the-meter (TTM) and make-ready costs per eligible vehicle purchased, capped at 25 vehicles. **Chargers**: Up to 50% of cost up to $42,000 towards charger costs.
Charge at Work Rebates for Businesses	Pacific Power (Oregon)	✓		✓		Customers agree to time of use enrollment if small non-residential customer (a consumer whose demand has not exceeded 30 KW or more) and commit to participation for 13 months. Customers	**Chargers**: Up to $1,000 awarded per port towards charger costs, not to exceed 75% of total costs. Max incentive is $6,000 (total 6 ports). Also offers grant-finding and writing support, and

Program Name	Utility	Program Offerings				Program Requirements	Program Incentive Levels
		Asses-sment	Make-Ready	Chargers	EVs		
						purchase and install qualified EV chargers (some chargers also require software to qualify), but installations must be hardwired for permanency. Customers must also submit a rebate application within one year of the date of purchase.	technical assessment or assistance with projects. Charger incentive cap is set at 75% of the total project costs, which can include charger, permit, or electrical work costs.
PSE Up & Go Electric for Fleet	Puget Sound Energy (PSE)	✓	✓	✓	✓	Customers are responsible for charger costs, annual maintenance costs, and ongoing electricity costs for at least 10 years and must procure at least two owned or leased EVs (or one if qualified Empower Mobility customer) for fleet by the EVSE installation and activation date.	**Make-ready and Chargers:** Multi-tiered Incentive up to $4,000 awarded per L2 port and up to $60,000 per DCFC port owned by customer, or up to $10,000 per L2 and up to $125,000 per DC fast charger owned by utility. Incentive capped at $250,000 per charging location. **Fleet vehicles:** Offers additional technical advisory services and enhanced incentives on both electric vehicle service equipment and electric vehicles to community-based organizations, Tribal entities, government agencies and BIPOC-owned small (Up to $2K per EV) businesses. Load management incentives are also offered.
Charge Ready Transport Program	Southern California Edison (SCE)	✓		✓		Customer must lease, purchase, or convert at least two medium- or heavy-duty battery-powered EVs, own or lease the property where chargers are installed, Make-ready incentive based on forecasted energy use of the chargers, up to $750,000 operate, and maintain chargers for a minimum of 10 years that are utility-approved, provide data related to charging equipment usage for at least 5 years (on-road vehicles only). All charging equipment will be	**Chargers:** Many customers, including transit agencies and businesses in disadvantaged communities that are not on the Fortune 1,000 list may qualify for an equipment rebate up to 50%.

Program Name	Utility	Program Offerings				Program Requirements	Program Incentive Levels
		Asses-sment	Make-Ready	Chargers	EVs		
						required to take service on a time-of-use rate plan.	
Power Your Drive for Fleets	San Diego Gas & Electric Company (SDG&E)	✓	✓	✓		Only applicable to Class 2-8, on-road and off-road fleet customers. Customer must provide data related to charger usage for a minimum of 5 years and operate and maintain vehicles and chargers for a minimum of 10 years. Chargers must meet a minimum of 19.2 kW charging capacity.	**Make-ready:** Two options (1) No cost installation and maintenance of utility side infrastructure. (2) Customer pays for, constructs, owns, and maintains all infrastructure up to the meter or "customer-side infrastructure" and charging stations and utility provides a rebate of up to 80% towards the costs. Per charger incentive caps are based on EVSE capacity ($3K for up to 19.2 kW, $15K for 19.3 kW to 50 kW, $45K for 50.1 kW to 150 kW, and $75K for over 150 kW). Rebate for each qualified charger not exceeding 50% of the cost. **Chargers:** Additional charger rebates up to $75,000 per charger or up to 50% of total charger costs for eligible customers in disadvantaged communities, whichever is lesser.
Fleet Electrification Program	Seattle City Light (SCL)	✓	✓	✓		Customers agree to behind-the-meter and to-the-meter utility-ownership terms for make-ready infrastructure. Customers are responsible for charger costs, annual maintenance costs, and ongoing electricity costs. Chargers must meet a minimum of 19.2 kW charging capacity.	**Make-ready and Chargers:** Up to 50% of total charger and make-ready infrastructure installation costs awarded to eligible customers in non-environmental justice community and additional financial assistance to fleets within environmental justice communities (up to 100% in total). Up to $4,000 and $50,000 provided per L2 and DC fast charger, respectively, for on-road electric equipment and up to $4,000 and $100,000 provided per L2 and DC fast charger, respectively,

Program Name	Utility	Program Offerings				Program Requirements	Program Incentive Levels
		Asses-sment	Make-Ready	Chargers	EVs		
							for non-road electric equipment. Make-ready incentives are subject to a cap of $200,000 per site and per customer or 50% of total charger and installation costs or the per-port incentive cap, whichever is lower. Additional funding caps per site may apply.
Commercial EV Program	SMUD (Sacramento Municipal Utility District)	✓	✓	✓	✓	Customers must be the utility customers of record at the location where the EVSE is located, must demonstrate adequate assurances of both physical and contractual permanence prior to receiving an incentive. Applicant will have 30 calendar days from date of inspection failure to bring the Project into compliance, or the Project will be dropped from the incentive program with option to reapply once the deficiencies are addressed.	**Make-ready and Chargers**: $500 to $4,500 per serviced EVSE (L1 or L2) and $7,500 to $30,000 for public-facing DC fast charger installation; $5,000 per transformer upgrade, $1,000 per panel upgrade support for new EVSE load, and $250 per stub out (infrastructure maintenance). Incentives cannot exceed 100% of project costs. **Fleet vehicles**: Rebate from $750 to $15,000 for EV costs.
EV Charging for My Fleet	Xcel Energy Colorado	✓		✓		Be a non-profit or public organization eligible to participate in Xcel Energy's non-profit efficiency programs or located in a Higher Emissions Community.	**Chargers**: Rebates up to $2,200 for L2 and Up to $45,000 for DC fast chargers, and up to $275,000 for electric school bus Projects

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